24-18733-02

PUBLIC

Ozarks Medical Center

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Liep T. Tio, M.D.
Radiation Oncologist

EMD WESTP
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April 13, 1994

Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, Illinois 60137

Re: NRC License Number 24-18733-02

Dear Sirs

We recently replaced our Cobalt-60 source in our AECL Theratron 780 Cobalt-60 treatment unit. Please find enclosed a copy of the Teletherapy Survey Report and the Calibration Report of the Cobalt-60 unit following replacement of the source.

If there are any questions or problems, please do not hesitate to contact us at (417) 257-7082.

Sincerely

Liep T. Tio, M.D.
Radiation Oncologist

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TELETHERAPY CALIBRATION REPORT

Facility:

Radiation Oncology Center
Doctors' Pavilion
1115 Alaska Ave, Suite 116
West Plains, Missouri 65775

License number: **24-18733-02**

Performed By:

Dennis Frieda, Ph.D.
Radiological Physicist (ABR)
3135 East Redbud
Springfield, MO 65804

On March 25-26, 1994, a complete calibration was performed on the A.E.C.L. Theratron 780 Teletherapy unit, serial no. 86, located in the Radiation Oncology Center, West Plains, Missouri. This unit is an isocentric Cobalt-60 teletherapy unit with a rotational isocenter of 80 centimeters. The unit has a newly installed Cobalt-60 source, serial no. S-4714, issued under NRC license no. 24-18733-02 with an initial activity of 7988 curies on March 4, 1994. The unit is located in the Radiation Oncology Center, Doctors' Pavilion, 1115 Alaska Avenue, Suite 116, West Plains, Missouri, 65775, phone (417)257-7082. The unit is under the supervision of Liep Tiong Tio, MD.

This report is a complete calibration of the above unit performed by Dennis Frieda, Ph.D. The calibration was performed using an NEL Farmer Dosemeter Model 2570SA2, serial no. 602, with an NEL (Farmer) Chamber Model 2571, serial no. 1063, which were last calibrated at the Accredited Dosimetry Calibration Laboratory, M. D. Anderson Hospital and Tumor Institute, Houston, Texas, on September 23, 1992.

A summary of the calibration findings follows with a copy of complete calibration data included in the appendix.

I. Equipment Evaluation

A. Control Console

1. The control console is located in an adjacent room with means provided for visual observation of the patient and control console from the same position. Means is also provided for oral communication between the patient and the control room. Patients are not to be treated unless visual and oral contact can be made with the patient at all times.

2. A key lock is provided on the control console to prevent unauthorized use. It is also not possible to activate the unit or beam from inside the treatment room.

3. Lights are located on the control console to indicate when the console is ON and when the source is in the ON position.

4. The control console has a timer to terminate exposure after a preset time. Means is also provided on the control console for the operator to terminate exposure at any time.

5. Emergency procedures are posted at the control console.

6. Emergency shut-off push buttons are provided on the control console and in the treatment room.

7. The door to the teletherapy treatment room is posted with a "Grave Danger - Very High Radiation Area" and a "Caution - Radioactive Materials" sign.

B. Interlocks and other warning lights and devices.

1. Lights are located on the control console, above the door to the treatment room and in the treatment room on the gantry head that indicate when the control console in ON and when the source is in the ON position.

2. Interlocks are provided such that the beam cannot be turned on if the door is open. If the door to the treatment room is opened while the beam is ON, the source will automatically return to the OFF position and cannot be turned ON until reset at the control console.

3. A radiation monitor is provided in the treatment room that emits a flashing red light that can be seen from the treatment room entrance when the source is ON. The monitor is provided with a working battery back-up.

4. A headlock is provided such that the source port can only be directed at the beam stopper.

5. No interlocks are provided for the wedges or blocking trays.

C. Mechanical Alignment

1. The coincidence of the central axis of the light field, the cross hairs, and the mechanical axis of the collimator assembly were checked and found to agree within 1.5 mm.

2. The field size indicators are analog and were found to be accurate to within 2 mm of the light field at 80 centimenters over the range of use.

3. The mechanical and optical distance indicators were checked and found to agree to within 1.5 mm. with the rotational isocenter of the unit. The optical distance indicator was found to be accurate to within 2 mm. with actual distances from the source for distances of 60 to 100 centimeters.

4. Films were exposed at 80 cm. SSD with 0.5 cm. of acrylic over the film and the edges of the actual radiation field was defined as the 50% isodensity as compared to the central axis isodensity. The radiation field edge verses light field edge were found to agree to within 1.5 mm. on all sides over the range of use.

II. Measurements

A. Beam Direction Dependence

The source output was found to exhibit a negilible variation (±0.1%) with beam (gantry) direction.

B. Field Flatness/Symmetry

Scans were performed in both the in-plane and cross-plane directions for 10X10 and 20X20 fields. Field flatness and symmetry were found to be satisfactory.

C. Timer

1. The timer accuracy was measured with a stop watch. Both timer accuracy and linearity were found to be satisfactory over the useful clinical range.

2. The source was found to exhibit a timer delay of -0.017 minute. Thus 0.017 minute should be added to the calculated timer setting for each OFF-ON-OFF movement of the source.

D. Central Axis Depth Dose

The table of Percentage Depth Dose data in use was taken from Supplement No. 17, "Central Axis Depth Dose Data for Use in Radiotherapy", *British Journal of Radiology*, 1983. The data was checked with measurements at depths of 5, 10, and

15 centimeters in a water phantom for field sizes of 6X6, 10X10 and 20X20 centimeters. The normalized calculated percent depth dose values were found to agree with table values to within 0.6% and indicate that the data in use is an appropriate choice for the unit. A table of the Tissue-Air Ratios (**TAR**) in use and also taken from Supplement No. 17 is also provided.

A table of Tissue-Maximum Ratios (**TMR**) calculated from the Tissue-Air Ratio data is also provided.

E. Dose Rate Calibration

The absorbed dose rate to tissue at d_{max} (depth of maximal dose) was determined from measurements at 5 centimeters in water for a 10X10 cm^2 field with an 80 centimeter source to surface distance (SSD). Using calculation methods of AAPM Protocol Task Group 21 (Dec., '83), the dose rate at d_{max} is given by:

$$\dot{D}_{max} = (\mathbf{M/U})\ \mathbf{N}_{gas}\ (L/\rho)^{water}_{air}\ \mathbf{P}_{wall}\ \mathbf{P}_{ion}\ \mathbf{P}_{repl}\ (100/\mathbf{P}_{\%})\ \mathbf{P}_{tissue}$$

where

M is the average of readings of the field instrument corrected for temperature and pressure;

U is the monitor unit, in this case, time (minutes), corrected for any end errors;

$\mathbf{N}_{gas}$ is the cavity-gas calibration factor;

$(L/\rho)^{water}_{air}$ is the mean restricted collision mass stopping power for medium (water) to air for Cobalt-60;

$\mathbf{P}_{wall}$ is the correction for attenuation and scatter for the wall of the chamber;

$\mathbf{P}_{ion}$ is the correction for ion-collection efficiency;

$\mathbf{P}_{repl}$ is the factor that corrects for replacement of phantom material by an ionization chamber;

$\mathbf{P}_{\%}$ is the percent depth dose at the point of measurement for selected field size and SSD; and

$\mathbf{P}_{tissue}$ is the factor that corrects dose to water to dose to tissue (P_{tissue} =0.99).

Using this formulation, the measured absorbed dose rate to tissue with full backscater at d_{max} for a 10X10 cm^2 field at 80 cm SSD is:

D_{max} = 215.7 cGy/minute on March 26, 1994

with a timer delay of -0.017 minute.

A table of decay corrected dose rates in tissue at d_{max} for a 10X10 cm^2 field at 80 cm SSD, for the next 12 months (April, 1994 thru March, 1995) is provided.

F. TLD Calibration Check

A check of the calibrated dose rate was made using TLDs from Radiation Dosimetry Services, The University of Texas M.D. Anderson Cancer Center. The TLDs have been returned to them for analysis and results are pending.

G. Field Size Dependence

The variation in output was measured over the range of field sizes at 80 cm SSD. Measurements were made at 5 cm depth in water, corrected for percent depth dose to d_{max}, and normalized to a 10X10 cm^2 field. The measured values vary from previous calibrated values (ie. values obtained with the previous source) by 0.5% or less with the larger variations occuring at larger field sizes. A table of Output Factors that uses the TAR(0.5) values (provided in the Tissue-Air Ratio table) to separate out a normalized collimator factor (S_c) and treatment area factor (S_p) is provided for clinical use.

H. Inverse Square Correction

The virtual source position was determined and found to agree to within 0.7 cm of the expected source position. Using inverse square, a source to isocenter distance of 80 cm is appropriate and accurate to within 0.4% for source to surface distances between 70 and 100 cm.

I. Transmission Factors

Transmission factors for the solid acrlyic blocking tray and the large (10w) 30, 45 and 60 degree wedges were measured in water at 5.0 cm depth. The measured values agreed with previous calibrated values (ie. values obtained with the previous source). A table of the values in clinical use is provided.

J. Arm Speed Calibration

The actual degrees rotated per minute verse arm speed setting was determined. The rotational speeds were found to differ slightly for motion in the counterclockwise(CCW) direction verses clockwise(CW) motion. For arm speed settings between 0.3 to 0.9, the following equations may be use to determine the arc speed setting:

CCW: $y = 0.00224x + 0.1266$ for $75 \leq x \leq 340$

CW: $y = 0.00228x + 0.1053$

where x = degree/min.

y = arm speed setting

Dennis Frieda, Ph.D.
Radiological Physicist (ABR)

DECAY CORRECTED DOSE RATES*

AECL Theratron 780 Cobalt-60 Teletherapy
Radiation Oncology Center
West Plains, Missouri

10 X 10 CM FIELD, 80 CM SSD
CALIBRATED OUTPUT* = 215.7 cGy/minute
at D_{max} in tissue with full backscatter
on March 26, 1994

Month	Decay Corrected† Output* (rads/minute)
April-1994	214.1
May-1994	211.8
June-1994	209.5
July-1994	207.2
August-1994	204.9
September-1994	202.7
October-1994	200.5
November-1994	198.2
December-1994	196.1
January-1995	193.9
February-1995	191.8
March-1995	189.8

* Includes timer error of -0.017 minute.

† Decay corrected to the 15th of each month.

MEASURED TRANSMISSION FACTORS*

AECL Theratron 780 Cobalt-60 Teletherapy
Radiation Oncology Center
West Plains, Missouri

BLOCKING TRAYS

	Measured Factor	Previous† Factor
Solid Plastic Tray	0.958	0.958

WEDGES

	Measured Factor	Previous† Factor
30° Wedge (10W x 15)	0.713	0.713
45° Wedge (10W x 15)	0.578	0.578
60° Wedge (10W x 15)	0.412	0.412

* Transmission factor = $\frac{\text{Dose rate with absorber}}{\text{Dose rate without absorber}}$

Measurement made at 5 cm depth in water phantom.

† Previous refers to clinical values using the old (replaced) source.

NORMALIZED MEASURED OUTPUT FACTORS

Theratron 780 Cobalt-60 Teletherapy
Radiation Oncology Center
West Plains, Missouri

Field Size (cm x cm)	Measured Output Factor*	Previous† Output Factor*
4.9 x 5.7	0.957	0.956
6.0 x 6.0	0.964	0.966
7.0 X 7.0	0.973	0.973
8.0 x 8.0	0.983	0.983
9.0 x 9.0	0.993	0.993
10.0 x 10.0	1.000	1.000
12.0 x 12.0	1.017	1.017
14.0 x 14.0	1.032	1.031
16.0 x 16.0	1.046	1.042
18.0 x 18.0	1.055	1.052
20.0 x 20.0	1.062	1.059
22.0 x 22.0	1.071	1.067
24.0 x 24.0	1.078	1.073
25.0 x 25.0	1.081	1.076
30.0 x 30.0	1.086	1.081
35.0 x 35.0	1.084	1.080

* Measurements made at 5 cm depth in water phantom with 80 cm SSD and normalized to 10 x 10 cm^2 field.

† Previous refers to clinical values using the old (replaced) source.

CLINICAL DATA

TRANSMISSION FACTORS*

AECL Theratron 780 Cobalt-60 Teletherapy
Radiation Oncology Center
West Plains, Missouri

BLOCKING TRAYS

Solid Plastic Tray	0.958

WEDGES

30° Wedge (10W x 15)	0.713
45° Wedge (10W x 15)	0.578
60° Wedge (10W x 15)	0.412

* Transmission factor = $\frac{\text{Dose rate with absorber}}{\text{Dose rate without absorber}}$

Measurement made at 5 cm depth in water phantom

OUTPUT FACTORS

AECL Theratron 780 Cobalt-60 Teletherapy
Radiation Oncology Center
West Plains, Missouri

Field Size (cm x cm)	Collimator Factor (S_c)	Treatment Area Factor (S_p)	Total Output Factor ($S_{c,p}$)
5.0 x 5.0	0.970	0.984	0.954
6.0 x 6.0	0.976	0.987	0.964
7.0 x 7.0	0.983	0.990	0.973
8.0 x 8.0	0.989	0.994	0.983
9.0 x 9.0	0.995	0.998	0.993
10.0 x 10.0	1.000	1.000	1.000
11.0 x 11.0	1.006	1.003	1.009
12.0 x 12.0	1.011	1.006	1.017
13.0 x 13.0	1.017	1.008	1.025
14.0 x 14.0	1.021	1.011	1.032
15.0 x 15.0	1.025	1.014	1.039
16.0 x 16.0	1.030	1.015	1.046
17.0 x 17.0	1.033	1.017	1.051
18.0 x 18.0	1.035	1.019	1.055
19.0 x 19.0	1.036	1.021	1.059
20.0 x 20.0	1.038	1.023	1.062
21.0 x 21.0	1.041	1.025	1.067
22.0 x 22.0	1.044	1.026	1.071
23.0 x 23.0	1.046	1.027	1.075
24.0 x 24.0	1.048	1.029	1.078
25.0 x 25.0	1.050	1.030	1.081
30.0 x 30.0	1.050	1.034	1.086
35.0 x 35.0	1.045	1.038	1.084

AECL THERATRON 780 COBALT-60 TAR TABLE

Field Size Depth, cm	4 x 4	5 x 5	6 x 6	7 x 7	8 x 8	9 x 9	10x10	11x11	12x12	13x13	14x14	15x15	16x16	17x17	18x18	19x19	20x20	Field Size Depth, cm
0.5	1.014	1.018	1.022	1.025	1.029	1.033	1.035	1.038	1.041	1.044	1.046	1.049	1.051	1.053	1.055	1.057	1.059	0.5
1.0	0.998	1.004	1.011	1.016	1.021	1.025	1.029	1.032	1.035	1.038	1.041	1.044	1.046	1.048	1.050	1.052	1.054	1.0
2.0	0.961	0.972	0.981	0.988	0.994	0.999	1.005	1.009	1.013	1.017	1.020	1.024	1.026	1.029	1.031	1.034	1.036	2.0
3.0	0.919	0.932	0.944	0.953	0.961	0.968	0.974	0.979	0.984	0.988	0.992	0.996	0.999	1.003	1.006	1.010	1.013	3.0
4.0	0.877	0.892	0.905	0.915	0.925	0.933	0.940	0.947	0.953	0.958	0.962	0.967	0.971	0.974	0.978	0.981	0.985	4.0
5.0	0.832	0.849	0.864	0.876	0.888	0.897	0.905	0.912	0.919	0.925	0.930	0.936	0.940	0.944	0.949	0.953	0.957	5.0
6.0	0.787	0.805	0.820	0.835	0.847	0.858	0.868	0.876	0.884	0.891	0.897	0.904	0.908	0.912	0.917	0.921	0.925	6.0
7.0	0.743	0.763	0.780	0.795	0.808	0.820	0.830	0.839	0.848	0.855	0.863	0.870	0.875	0.879	0.884	0.888	0.893	7.0
8.0	0.702	0.721	0.738	0.754	0.768	0.780	0.791	0.801	0.810	0.818	0.826	0.834	0.839	0.845	0.850	0.856	0.861	8.0
9.0	0.660	0.680	0.699	0.715	0.729	0.742	0.755	0.765	0.775	0.783	0.791	0.799	0.805	0.811	0.816	0.822	0.828	9.0
10.0	0.620	0.642	0.659	0.676	0.692	0.706	0.718	0.728	0.738	0.747	0.756	0.765	0.771	0.777	0.783	0.789	0.795	10.0
11.0	0.585	0.604	0.623	0.639	0.654	0.663	0.680	0.691	0.702	0.711	0.720	0.729	0.736	0.742	0.749	0.755	0.762	11.0
12.0	0.550	0.570	0.587	0.603	0.618	0.632	0.646	0.657	0.668	0.677	0.687	0.696	0.703	0.710	0.716	0.723	0.730	12.0
13.0	0.517	0.536	0.553	0.569	0.584	0.598	0.612	0.624	0.635	0.644	0.654	0.663	0.670	0.677	0.685	0.692	0.699	13.0
14.0	0.487	0.505	0.521	0.539	0.553	0.566	0.579	0.591	0.602	0.611	0.621	0.630	0.638	0.645	0.653	0.660	0.668	14.0
15.0	0.457	0.474	0.491	0.507	0.520	0.533	0.547	0.559	0.571	0.581	0.590	0.600	0.608	0.615	0.623	0.630	0.638	15.0
16.0	0.431	0.448	0.463	0.477	0.491	0.505	0.518	0.530	0.542	0.552	0.561	0.571	0.579	0.586	0.594	0.601	0.609	16.0
17.0	0.403	0.420	0.436	0.450	0.463	0.477	0.490	0.501	0.512	0.522	0.532	0.542	0.550	0.557	0.565	0.572	0.580	17.0
18.0	0.380	0.395	0.410	0.425	0.439	0.451	0.463	0.474	0.485	0.495	0.504	0.514	0.522	0.530	0.537	0.545	0.553	18.0
19.0	0.356	0.370	0.385	0.399	0.412	0.425	0.438	0.449	0.459	0.469	0.478	0.488	0.496	0.503	0.511	0.518	0.526	19.0
20.0	0.335	0.348	0.362	0.375	0.387	0.399	0.411	0.422	0.433	0.443	0.452	0.462	0.470	0.477	0.485	0.492	0.500	20.0
21.0	0.316	0.328	0.342	0.354	0.366	0.378	0.389	0.400	0.411	0.420	0.430	0.439	0.447	0.454	0.462	0.469	0.477	21.0
22.0	0.297	0.308	0.321	0.333	0.344	0.356	0.367	0.378	0.388	0.397	0.407	0.416	0.423	0.431	0.438	0.446	0.453	22.0
23.0	0.279	0.290	0.303	0.314	0.325	0.336	0.347	0.357	0.367	0.376	0.385	0.395	0.402	0.409	0.416	0.424	0.431	23.0
24.0	0.260	0.272	0.284	0.295	0.305	0.316	0.326	0.336	0.346	0.355	0.364	0.373	0.380	0.387	0.395	0.402	0.409	24.0
25.0	0.245	0.256	0.267	0.278	0.288	0.299	0.309	0.318	0.328	0.336	0.345	0.354	0.361	0.368	0.375	0.382	0.390	25.0
26.0	0.230	0.239	0.250	0.261	0.270	0.281	0.291	0.300	0.309	0.318	0.326	0.335	0.342	0.349	0.356	0.363	0.370	26.0
27.0	0.217	0.226	0.236	0.246	0.255	0.266	0.276	0.284	0.293	0.301	0.309	0.317	0.324	0.331	0.338	0.345	0.352	27.0
28.0	0.203	0.212	0.222	0.231	0.240	0.250	0.260	0.268	0.276	0.284	0.291	0.299	0.306	0.313	0.320	0.327	0.334	28.0
29.0	0.191	0.200	0.209	0.218	0.227	0.236	0.245	0.253	0.261	0.268	0.276	0.284	0.290	0.297	0.304	0.310	0.317	29.0
30.0	0.178	0.187	0.196	0.205	0.213	0.221	0.229	0.237	0.245	0.253	0.260	0.268	0.274	0.281	0.287	0.294	0.300	30.0

AECL THERATRON 780 COBALT-60 TAR TABLE

Field Size Depth, cm	20x20	21x21	22x22	23x23	24x24	25x25	26x26	27x27	28x28	29x29	30x30	31x31	32x32	33x33	34x34	35x35	Field Size Depth, cm
0.5	1.059	1.060	1.062	1.063	1.065	1.066	1.067	1.068	1.068	1.069	1.070	1.071	1.072	1.072	1.073	1.074	0.5
1.0	1.054	1.056	1.057	1.059	1.060	1.062	1.063	1.064	1.065	1.066	1.067	1.068	1.069	1.069	1.070	1.071	1.0
2.0	1.036	1.038	1.040	1.041	1.043	1.045	1.046	1.047	1.049	1.050	1.051	1.052	1.053	1.054	1.055	1.056	2.0
3.0	1.013	1.015	1.017	1.018	1.020	1.022	1.023	1.025	1.026	1.028	1.029	1.030	1.031	1.032	1.033	1.034	3.0
4.0	0.985	0.987	0.989	0.992	0.994	0.996	0.998	0.999	1.001	1.002	1.004	1.005	1.006	1.008	1.009	1.010	4.0
5.0	0.957	0.959	0.962	0.964	0.967	0.969	0.971	0.973	0.974	0.976	0.978	0.979	0.980	0.982	0.983	0.984	5.0
6.0	0.925	0.928	0.931	0.934	0.937	0.940	0.942	0.944	0.946	0.948	0.950	0.952	0.953	0.955	0.956	0.958	6.0
7.0	0.893	0.896	0.899	0.902	0.905	0.908	0.910	0.913	0.915	0.918	0.920	0.922	0.923	0.925	0.926	0.928	7.0
8.0	0.861	0.865	0.868	0.872	0.875	0.879	0.882	0.884	0.887	0.889	0.892	0.894	0.895	0.897	0.898	0.900	8.0
9.0	0.828	0.832	0.836	0.839	0.843	0.847	0.850	0.853	0.855	0.858	0.861	0.863	0.865	0.867	0.869	0.871	9.0
10.0	0.795	0.799	0.803	0.808	0.812	0.816	0.819	0.822	0.824	0.827	0.830	0.832	0.834	0.837	0.839	0.841	10.0
11.0	0.762	0.766	0.771	0.775	0.780	0.784	0.787	0.790	0.794	0.797	0.800	0.802	0.804	0.807	0.809	0.811	11.0
12.0	0.730	0.735	0.739	0.744	0.748	0.753	0.756	0.760	0.763	0.767	0.770	0.772	0.775	0.777	0.780	0.782	12.0
13.0	0.699	0.704	0.709	0.713	0.718	0.723	0.727	0.730	0.734	0.737	0.741	0.744	0.747	0.749	0.752	0.755	13.0
14.0	0.668	0.673	0.678	0.683	0.688	0.693	0.697	0.700	0.704	0.707	0.711	0.714	0.717	0.720	0.723	0.726	14.0
15.0	0.638	0.643	0.648	0.654	0.659	0.664	0.668	0.672	0.675	0.679	0.683	0.686	0.689	0.692	0.695	0.698	15.0
16.0	0.609	0.614	0.620	0.625	0.631	0.636	0.640	0.644	0.647	0.651	0.655	0.658	0.661	0.665	0.668	0.671	16.0
17.0	0.580	0.585	0.591	0.596	0.602	0.607	0.611	0.615	0.619	0.623	0.627	0.630	0.634	0.637	0.641	0.644	17.0
18.0	0.553	0.558	0.564	0.569	0.575	0.580	0.584	0.588	0.592	0.596	0.600	0.604	0.607	0.611	0.614	0.618	18.0
19.0	0.526	0.531	0.537	0.542	0.548	0.553	0.557	0.562	0.566	0.571	0.575	0.578	0.582	0.585	0.589	0.592	19.0
20.0	0.500	0.505	0.511	0.516	0.522	0.527	0.531	0.535	0.540	0.544	0.548	0.552	0.555	0.559	0.562	0.566	20.0
21.0	0.477	0.482	0.488	0.493	0.499	0.504	0.508	0.513	0.517	0.521	0.526	0.529	0.533	0.537	0.540	0.544	21.0
22.0	0.453	0.459	0.464	0.470	0.475	0.481	0.485	0.490	0.494	0.499	0.503	0.507	0.511	0.514	0.518	0.522	22.0
23.0	0.431	0.437	0.442	0.448	0.453	0.459	0.463	0.468	0.472	0.476	0.481	0.484	0.488	0.492	0.496	0.500	23.0
24.0	0.409	0.415	0.420	0.426	0.431	0.437	0.441	0.445	0.450	0.454	0.458	0.462	0.466	0.469	0.473	0.477	24.0
25.0	0.390	0.395	0.400	0.406	0.411	0.417	0.421	0.425	0.429	0.433	0.438	0.441	0.445	0.449	0.453	0.457	25.0
26.0	0.370	0.375	0.380	0.386	0.391	0.396	0.400	0.404	0.409	0.413	0.417	0.421	0.425	0.428	0.432	0.436	26.0
27.0	0.352	0.357	0.362	0.368	0.373	0.378	0.382	0.387	0.391	0.395	0.400	0.403	0.407	0.411	0.414	0.418	27.0
28.0	0.334	0.339	0.344	0.350	0.355	0.360	0.364	0.369	0.373	0.378	0.382	0.386	0.389	0.393	0.396	0.400	28.0
29.0	0.317	0.322	0.327	0.333	0.338	0.343	0.347	0.352	0.356	0.360	0.365	0.368	0.372	0.375	0.379	0.383	29.0
30.0	0.300	0.305	0.310	0.316	0.321	0.326	0.330	0.334	0.339	0.343	0.347	0.351	0.354	0.358	0.361	0.365	30.0

AECL THERATRON 780 COBALT-60 TMR TABLE

Field Size Depth, cm	4 x 4	5 x 5	6 x 6	7 x 7	8 x 8	9 x 9	10x10	11x11	12x12	13x13	14x14	15x15	16x16	17x17	18x18	19x19	20x20	Field Size Depth, cm
0.5	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.5
1.0	0.984	0.986	0.989	0.991	0.992	0.992	0.994	0.994	0.994	0.995	0.995	0.995	0.995	0.995	0.995	0.995	0.995	1.0
2.0	0.948	0.955	0.960	0.964	0.966	0.967	0.971	0.972	0.973	0.974	0.975	0.976	0.977	0.977	0.977	0.978	0.978	2.0
3.0	0.906	0.916	0.924	0.930	0.934	0.937	0.941	0.943	0.945	0.947	0.948	0.949	0.951	0.952	0.954	0.955	0.957	3.0
4.0	0.865	0.876	0.886	0.893	0.899	0.903	0.908	0.912	0.915	0.918	0.920	0.922	0.924	0.925	0.927	0.928	0.930	4.0
5.0	0.821	0.834	0.845	0.855	0.863	0.868	0.874	0.879	0.883	0.886	0.889	0.892	0.895	0.897	0.899	0.901	0.904	5.0
6.0	0.776	0.791	0.802	0.815	0.823	0.831	0.839	0.844	0.849	0.853	0.858	0.862	0.864	0.866	0.869	0.871	0.873	6.0
7.0	0.733	0.750	0.763	0.776	0.785	0.794	0.802	0.808	0.815	0.820	0.824	0.829	0.832	0.835	0.838	0.840	0.843	7.0
8.0	0.692	0.708	0.722	0.736	0.746	0.755	0.764	0.771	0.778	0.784	0.789	0.795	0.799	0.802	0.806	0.809	0.813	8.0
9.0	0.651	0.668	0.684	0.698	0.708	0.718	0.729	0.737	0.744	0.750	0.756	0.762	0.766	0.770	0.774	0.778	0.782	9.0
10.0	0.611	0.631	0.645	0.660	0.672	0.683	0.694	0.701	0.709	0.716	0.723	0.729	0.734	0.738	0.742	0.746	0.751	10.0
11.0	0.577	0.593	0.610	0.623	0.636	0.642	0.657	0.666	0.674	0.681	0.688	0.695	0.700	0.705	0.710	0.715	0.720	11.0
12.0	0.542	0.560	0.574	0.588	0.601	0.612	0.624	0.633	0.642	0.649	0.656	0.663	0.669	0.674	0.679	0.684	0.689	12.0
13.0	0.510	0.527	0.541	0.555	0.568	0.579	0.591	0.601	0.610	0.617	0.625	0.632	0.638	0.643	0.649	0.654	0.660	13.0
14.0	0.480	0.496	0.510	0.526	0.537	0.548	0.559	0.569	0.578	0.586	0.593	0.601	0.607	0.613	0.619	0.625	0.631	14.0
15.0	0.451	0.466	0.480	0.495	0.505	0.516	0.529	0.539	0.549	0.556	0.564	0.572	0.578	0.584	0.590	0.596	0.602	15.0
16.0	0.425	0.440	0.453	0.465	0.477	0.489	0.500	0.511	0.521	0.529	0.536	0.544	0.551	0.557	0.563	0.569	0.575	16.0
17.0	0.397	0.413	0.427	0.439	0.450	0.462	0.473	0.483	0.492	0.500	0.508	0.517	0.523	0.529	0.535	0.542	0.548	17.0
18.0	0.375	0.388	0.401	0.415	0.427	0.437	0.447	0.457	0.466	0.474	0.482	0.490	0.496	0.503	0.509	0.516	0.522	18.0
19.0	0.351	0.363	0.377	0.389	0.400	0.411	0.423	0.432	0.441	0.449	0.457	0.465	0.472	0.478	0.484	0.490	0.497	19.0
20.0	0.330	0.342	0.354	0.366	0.376	0.386	0.397	0.407	0.416	0.424	0.432	0.440	0.447	0.453	0.460	0.466	0.472	20.0
21.0	0.312	0.322	0.334	0.345	0.355	0.365	0.376	0.385	0.394	0.402	0.410	0.418	0.425	0.431	0.437	0.444	0.450	21.0
22.0	0.293	0.303	0.314	0.325	0.334	0.345	0.355	0.364	0.373	0.381	0.389	0.397	0.403	0.409	0.415	0.422	0.428	22.0
23.0	0.275	0.285	0.296	0.306	0.315	0.325	0.335	0.344	0.353	0.360	0.368	0.376	0.382	0.389	0.395	0.401	0.407	23.0
24.0	0.256	0.267	0.278	0.288	0.296	0.306	0.315	0.324	0.332	0.340	0.348	0.356	0.362	0.368	0.374	0.380	0.386	24.0
25.0	0.242	0.251	0.261	0.271	0.279	0.289	0.298	0.306	0.315	0.322	0.330	0.337	0.344	0.350	0.356	0.362	0.368	25.0
26.0	0.227	0.235	0.245	0.255	0.262	0.272	0.281	0.289	0.297	0.304	0.312	0.319	0.325	0.331	0.337	0.343	0.349	26.0
27.0	0.214	0.222	0.231	0.240	0.248	0.257	0.266	0.274	0.281	0.288	0.295	0.302	0.308	0.314	0.320	0.326	0.332	27.0
28.0	0.200	0.208	0.217	0.225	0.233	0.242	0.251	0.258	0.265	0.272	0.278	0.285	0.291	0.297	0.303	0.309	0.315	28.0
29.0	0.188	0.196	0.205	0.213	0.220	0.228	0.236	0.243	0.250	0.257	0.264	0.270	0.276	0.282	0.288	0.294	0.299	29.0
30.0	0.176	0.184	0.192	0.200	0.207	0.214	0.221	0.228	0.235	0.242	0.249	0.255	0.261	0.267	0.272	0.278	0.283	30.0

AECL THERATRON 780 COBALT-60 TMR TABLE

Field Size Depth, cm	20x20	21x21	22x22	23x23	24x24	25x25	26x26	27x27	28x28	29x29	30x30	31x31	32x32	33x33	34x34	35x35	Field Size Depth, cm
0.5	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.5
1.0	0.995	0.995	0.996	0.996	0.996	0.996	0.996	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	1.0
2.0	0.978	0.979	0.979	0.979	0.980	0.980	0.981	0.981	0.981	0.982	0.982	0.982	0.983	0.983	0.983	0.983	2.0
3.0	0.957	0.957	0.957	0.958	0.958	0.959	0.959	0.960	0.961	0.961	0.962	0.962	0.962	0.962	0.963	0.963	3.0
4.0	0.930	0.931	0.932	0.933	0.933	0.934	0.935	0.936	0.937	0.938	0.938	0.939	0.939	0.940	0.940	0.940	4.0
5.0	0.904	0.905	0.906	0.907	0.908	0.909	0.910	0.911	0.912	0.913	0.914	0.914	0.915	0.915	0.916	0.916	5.0
6.0	0.873	0.875	0.877	0.878	0.880	0.882	0.883	0.884	0.885	0.887	0.888	0.889	0.890	0.890	0.891	0.892	6.0
7.0	0.843	0.845	0.847	0.848	0.850	0.852	0.853	0.855	0.857	0.858	0.860	0.861	0.862	0.862	0.863	0.864	7.0
8.0	0.813	0.815	0.818	0.820	0.822	0.825	0.826	0.828	0.830	0.832	0.834	0.835	0.835	0.836	0.837	0.838	8.0
9.0	0.782	0.784	0.787	0.790	0.792	0.795	0.797	0.799	0.801	0.803	0.805	0.806	0.807	0.808	0.810	0.811	9.0
10.0	0.751	0.754	0.757	0.760	0.763	0.765	0.768	0.770	0.772	0.774	0.776	0.777	0.779	0.780	0.782	0.783	10.0
11.0	0.720	0.723	0.726	0.729	0.732	0.735	0.738	0.740	0.743	0.745	0.748	0.749	0.751	0.752	0.754	0.755	11.0
12.0	0.689	0.693	0.696	0.700	0.703	0.706	0.709	0.712	0.714	0.717	0.720	0.721	0.723	0.725	0.726	0.728	12.0
13.0	0.660	0.664	0.667	0.671	0.675	0.678	0.681	0.684	0.687	0.690	0.693	0.695	0.697	0.699	0.701	0.703	13.0
14.0	0.631	0.635	0.639	0.642	0.646	0.650	0.653	0.656	0.659	0.662	0.664	0.667	0.669	0.671	0.674	0.676	14.0
15.0	0.602	0.607	0.611	0.615	0.619	0.623	0.626	0.629	0.632	0.635	0.638	0.641	0.643	0.645	0.648	0.650	15.0
16.0	0.575	0.579	0.584	0.588	0.592	0.597	0.600	0.603	0.606	0.609	0.612	0.615	0.617	0.620	0.622	0.625	16.0
17.0	0.548	0.552	0.556	0.561	0.565	0.569	0.573	0.576	0.579	0.583	0.586	0.589	0.591	0.594	0.597	0.600	17.0
18.0	0.522	0.527	0.531	0.535	0.540	0.544	0.547	0.551	0.554	0.557	0.561	0.564	0.567	0.570	0.572	0.575	18.0
19.0	0.497	0.501	0.506	0.510	0.514	0.519	0.522	0.526	0.530	0.534	0.537	0.540	0.543	0.546	0.548	0.551	19.0
20.0	0.472	0.477	0.481	0.486	0.490	0.494	0.498	0.501	0.505	0.509	0.512	0.515	0.518	0.521	0.524	0.527	20.0
21.0	0.450	0.455	0.459	0.464	0.468	0.473	0.476	0.480	0.484	0.487	0.491	0.494	0.497	0.500	0.503	0.507	21.0
22.0	0.428	0.432	0.437	0.442	0.447	0.451	0.455	0.459	0.463	0.466	0.470	0.473	0.476	0.480	0.483	0.486	22.0
23.0	0.407	0.412	0.416	0.421	0.426	0.431	0.434	0.438	0.442	0.445	0.449	0.452	0.455	0.459	0.462	0.465	23.0
24.0	0.386	0.391	0.396	0.400	0.405	0.410	0.414	0.417	0.421	0.424	0.428	0.431	0.434	0.438	0.441	0.444	24.0
25.0	0.368	0.372	0.377	0.382	0.386	0.391	0.394	0.398	0.402	0.405	0.409	0.412	0.415	0.419	0.422	0.425	25.0
26.0	0.349	0.354	0.358	0.363	0.367	0.371	0.375	0.379	0.382	0.386	0.390	0.393	0.396	0.399	0.403	0.406	26.0
27.0	0.332	0.337	0.341	0.346	0.350	0.355	0.358	0.362	0.366	0.370	0.373	0.377	0.380	0.383	0.386	0.389	27.0
28.0	0.315	0.320	0.324	0.329	0.333	0.338	0.342	0.345	0.349	0.353	0.357	0.360	0.363	0.366	0.369	0.372	28.0
29.0	0.299	0.304	0.308	0.313	0.317	0.322	0.326	0.329	0.333	0.337	0.341	0.344	0.347	0.350	0.353	0.356	29.0
30.0	0.283	0.288	0.292	0.297	0.301	0.306	0.310	0.313	0.317	0.321	0.324	0.327	0.331	0.334	0.337	0.340	30.0

AECL THERATRON 780 COBALT-60 PERCENT DEPTH DOSE (80 CM SSD)

Field Size / Depth, cm	4 x 4	5 x 5	6 x 6	7 x 7	8 x 8	9 x 9	10x10	11X11	12x12	13X13	14x14	15x15	16x16	17x17	18x18	19x19	20x20	Field Size / Depth, cm
0.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.5
1.0	97.2	97.5	97.7	97.8	97.9	98.0	98.1	98.2	98.2	98.2	98.3	98.3	98.3	98.3	98.3	98.3	98.3	1.0
2.0	91.4	92.1	92.6	93.0	93.2	93.4	93.7	93.8	93.9	94.0	94.0	94.1	94.1	94.2	94.2	94.3	94.3	2.0
3.0	85.4	86.3	87.0	87.6	88.0	88.4	88.7	88.9	89.1	89.2	89.4	89.5	89.6	89.7	89.9	90.0	90.1	3.0
4.0	79.7	80.7	81.6	82.3	82.8	83.2	83.7	84.0	84.3	84.5	84.7	84.9	85.0	85.2	85.3	85.5	85.6	4.0
5.0	73.9	75.2	76.2	77.1	77.8	78.3	78.8	79.2	79.5	79.8	80.0	80.3	80.5	80.7	80.9	81.1	81.3	5.0
6.0	68.4	69.7	70.8	71.9	72.6	73.3	73.9	74.4	74.9	75.2	75.6	75.9	76.1	76.3	76.5	76.7	76.9	6.0
7.0	63.3	64.7	66.0	67.0	67.9	68.6	69.3	69.8	70.3	70.7	71.1	71.5	71.7	71.9	72.2	72.4	72.6	7.0
8.0	58.5	59.9	61.2	62.3	63.2	64.0	64.7	65.3	65.8	66.2	66.7	67.1	67.4	67.7	68.0	68.3	68.6	8.0
9.0	53.9	55.5	56.8	57.9	58.8	59.7	60.5	61.1	61.7	62.1	62.6	63.0	63.3	63.6	64.0	64.3	64.6	9.0
10.0	49.7	51.2	52.5	53.8	54.8	55.7	56.4	57.1	57.7	58.2	58.7	59.2	59.5	59.8	60.2	60.5	60.8	10.0
11.0	45.9	47.4	48.7	49.8	50.7	51.6	52.5	53.2	53.8	54.3	54.8	55.3	55.7	56.1	56.4	56.8	57.2	11.0
12.0	42.4	43.8	45.0	46.2	47.2	48.1	48.9	49.6	50.3	50.8	51.4	51.9	52.3	52.6	53.0	53.3	53.7	12.0
13.0	39.1	40.4	41.6	42.8	43.8	44.7	45.6	46.3	47.0	47.5	48.1	48.6	49.0	49.4	49.7	50.1	50.5	13.0
14.0	36.1	37.3	38.7	39.7	40.7	41.6	42.4	43.1	43.7	44.3	44.8	45.4	45.8	46.2	46.6	47.0	47.4	14.0
15.0	33.2	34.5	35.7	36.7	37.6	38.5	39.4	40.1	40.8	41.4	41.9	42.5	42.9	43.3	43.7	44.1	44.5	15.0
16.0	30.8	31.9	33.0	34.0	35.0	35.9	36.8	37.5	38.1	38.6	39.2	39.7	40.1	40.5	41.0	41.4	41.8	16.0
17.0	28.3	29.5	30.5	31.5	32.5	33.3	34.1	34.8	35.5	36.0	36.6	37.1	37.5	37.9	38.4	38.8	39.2	17.0
18.0	26.2	27.3	28.3	29.3	30.2	30.9	31.7	32.4	33.1	33.6	34.2	34.7	35.1	35.5	35.9	36.3	36.7	18.0
19.0	24.1	25.1	26.1	27.1	28.0	28.8	29.5	30.2	30.8	31.3	31.9	32.4	32.8	33.2	33.6	34.0	34.4	19.0
20.0	22.2	23.2	24.1	25.0	25.8	26.6	27.4	28.1	28.7	29.2	29.7	30.2	30.6	31.0	31.4	31.8	32.2	20.0
21.0	20.6	21.6	22.4	23.3	24.1	24.8	25.6	26.2	26.9	27.4	27.9	28.4	28.7	29.1	29.5	29.9	30.3	21.0
22.0	19.0	19.9	20.7	21.5	22.3	23.0	23.7	24.4	25.0	25.5	26.0	26.5	26.9	27.3	27.6	28.0	28.4	22.0
23.0	17.6	18.5	19.2	20.0	20.8	21.5	22.1	22.7	23.4	23.8	24.3	24.8	25.2	25.5	25.9	26.3	26.7	23.0
24.0	16.2	17.0	17.7	18.5	19.2	19.9	20.5	21.1	21.7	22.2	22.6	23.1	23.5	23.8	24.2	24.5	24.9	24.0
25.0	15.0	15.8	16.5	17.2	17.9	18.6	19.2	19.7	20.3	20.8	21.2	21.7	22.0	22.4	22.7	23.1	23.4	25.0
26.0	13.8	14.5	15.2	15.9	16.6	17.2	17.8	18.4	18.9	19.3	19.8	20.2	20.5	20.9	21.2	21.6	21.9	26.0
27.0	12.8	13.5	14.2	14.9	15.5	16.1	16.6	17.1	17.7	18.1	18.5	19.0	19.3	19.6	19.9	20.3	20.6	27.0
28.0	11.8	12.5	13.1	13.8	14.4	14.9	15.4	15.9	16.4	16.8	17.3	17.7	18.0	18.3	18.7	19.0	19.3	28.0
29.0	11.0	11.6	12.2	12.8	13.4	13.9	14.4	14.8	15.3	15.7	16.1	16.6	16.9	17.2	17.5	17.8	18.2	29.0
30.0	10.1	10.7	11.2	11.8	12.3	12.8	13.3	13.8	14.2	14.6	15.0	15.4	15.7	16.0	16.4	16.7	17.0	30.0

AECL THERATRON 780 COBALT-60 PERCENT DEPTH DOSE (80 CM SSD)

Field Size Depth, cm	20x20	21x21	22x22	23x23	24x24	25x25	26x26	27x27	28x28	29x29	30x30	31X31	32x32	33X33	34X34	35x35	Field Size Depth, cm
0.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.5
1.0	98.3	98.3	98.3	98.4	98.4	98.4	98.4	98.4	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5	1.0
2.0	94.3	94.3	94.4	94.4	94.5	94.5	94.5	94.6	94.6	94.7	94.7	94.7	94.7	94.8	94.8	94.8	2.0
3.0	90.1	90.1	90.2	90.2	90.3	90.3	90.3	90.4	90.4	90.5	90.5	90.5	90.5	90.6	90.6	90.6	3.0
4.0	85.6	85.7	85.8	85.8	85.9	86.0	86.1	86.1	86.2	86.2	86.3	86.3	86.4	86.4	86.5	86.5	4.0
5.0	81.3	81.4	81.5	81.5	81.6	81.7	81.8	81.9	81.9	82.0	82.1	82.2	82.2	82.3	82.3	82.4	5.0
6.0	76.9	77.0	77.1	77.3	77.4	77.5	77.6	77.7	77.9	78.0	78.1	78.2	78.2	78.3	78.3	78.4	6.0
7.0	72.6	72.7	72.9	73.0	73.2	73.3	73.4	73.5	73.7	73.8	73.9	74.0	74.1	74.1	74.2	74.3	7.0
8.0	68.6	68.8	69.0	69.1	69.3	69.5	69.7	69.7	69.9	70.0	70.1	70.2	70.3	70.3	70.4	70.5	8.0
9.0	64.6	64.8	65.0	65.2	65.4	65.6	65.7	65.9	66.0	66.2	66.3	66.4	66.5	66.6	66.7	66.8	9.0
10.0	60.8	61.0	61.2	61.5	61.7	61.9	62.0	62.2	62.3	62.5	62.6	62.7	62.8	63.0	63.1	63.2	10.0
11.0	57.2	57.4	57.6	57.9	58.1	58.3	58.5	58.6	58.8	58.9	59.1	59.2	59.4	59.5	59.7	59.8	11.0
12.0	53.7	54.0	54.2	54.5	54.7	55.0	55.2	55.3	55.5	55.6	55.8	55.9	56.1	56.2	56.4	56.5	12.0
13.0	50.5	50.8	51.0	51.3	51.5	51.8	52.0	52.2	52.4	52.6	52.8	52.9	53.0	53.2	53.3	53.4	13.0
14.0	47.4	47.7	47.9	48.2	48.4	48.7	48.9	49.1	49.4	49.6	49.8	49.9	50.1	50.2	50.4	50.5	14.0
15.0	44.5	44.8	45.1	45.3	45.6	45.9	46.1	46.3	46.5	46.7	46.9	47.0	47.2	47.3	47.5	47.6	15.0
16.0	41.8	42.1	42.4	42.6	42.9	43.2	43.4	43.6	43.8	44.0	44.2	44.4	44.5	44.7	44.8	45.0	16.0
17.0	39.2	39.5	39.7	40.0	40.2	40.5	40.7	40.9	41.2	41.4	41.6	41.8	41.9	42.1	42.2	42.4	17.0
18.0	36.7	37.0	37.3	37.5	37.8	38.1	38.3	38.5	38.8	39.0	39.2	39.3	39.5	39.6	39.8	39.9	18.0
19.0	34.4	34.7	35.0	35.2	35.5	35.8	36.0	36.2	36.5	36.7	36.9	37.1	37.2	37.4	37.5	37.7	19.0
20.0	32.2	32.5	32.7	33.0	33.2	33.5	33.7	34.0	34.2	34.5	34.7	34.9	35.0	35.2	35.3	35.5	20.0
21.0	30.3	30.6	30.8	31.1	31.4	31.7	31.9	32.1	32.3	32.5	32.8	32.9	33.1	33.2	33.4	33.5	21.0
22.0	28.4	28.7	29.0	29.2	29.5	29.8	30.0	30.2	30.4	30.6	30.8	30.9	31.1	31.2	31.4	31.5	22.0
23.0	26.7	26.9	27.2	27.5	27.7	28.0	28.2	28.4	28.6	28.8	29.1	29.2	29.4	29.5	29.7	29.8	23.0
24.0	24.9	25.2	25.4	25.7	25.9	26.2	26.4	26.6	26.9	27.1	27.3	27.5	27.6	27.8	27.9	28.1	24.0
25.0	23.4	23.7	23.9	24.2	24.4	24.7	24.9	25.1	25.3	25.5	25.8	25.9	26.1	26.2	26.4	26.5	25.0
26.0	21.9	22.2	22.4	22.7	22.9	23.2	23.4	23.6	23.8	24.0	24.2	24.3	24.5	24.6	24.8	24.9	26.0
27.0	20.6	20.9	21.1	21.4	21.6	21.9	22.1	22.3	22.5	22.7	22.9	23.0	23.1	23.2	23.4	23.5	27.0
28.0	19.3	19.6	19.8	20.1	20.3	20.6	20.8	21.0	21.1	21.3	21.5	21.6	21.7	21.9	22.0	22.1	28.0
29.0	18.2	18.4	18.7	18.9	19.2	19.4	19.6	19.7	19.9	20.1	20.3	20.4	20.5	20.6	20.7	20.9	29.0
30.0	17.0	17.2	17.5	17.7	18.0	18.2	18.4	18.5	18.7	18.8	19.0	19.1	19.2	19.4	19.5	19.6	30.0

APPENDIX

Calibration Report Survey

Name of Facility: Radiation Oncology Center Date: 3/25/94

Address: Ozarks Medical Center
1115 Alaska Ave, Suite 116
West Plains, MO

Telephone: (417) 257-7082

Type of Unit: AECL Theratron 780

Manufacturer: Atomic Energy of Canada, Ltd (now Theratronics)

Equipment Identification: AECL Theratron 780 (SN: 86)
Source is a 2.0 cm diameter standard source type C-146 (SN: S-4714)
Room Location: containing 295.5 TBq (7958 Curies) on March 4, 1994.

Description: Cobalt-60 Isocentric Rotational Unit.

Person(s) Responsible, include title:

A. Liep Tio, M.D. Director

B.

C.

Assigned Operating Personnel:

A. Lisa Hartog RT(R)(T)

B.

C.

Physicist(s) Making Report:

A. Dennis Frieda, Ph.D., Radiological Physicist

B.

Instruments Used:

A. NEL 2570 Dosemeter, Serial #602, Model 2570SA2

B. NEL Model 2571 Chamber, Serial #1063

C.

Dennis Frieda

Physicist

Radiation Protection Survey Date: 3/25/94

Institution: RADIATION ONCOLOGY CENTER
1115 Alaska Ave, Suite 1/6
West Plains, MO

Unit: AECL THERATRON 780

Room Location: _____

Type of Treatment: FIXED AND ROTATIONAL

Adequate interlock system (doors, filters, wedges) Interlock for door to treatment room, no interlocks for WEDGES or Blocks

Patient and control observed simultaneously YES, Monitor at control console.

Patient - operator communication available YES, intercom to room at control console.

Radiation Area Posted YES, on door to treatment room.

Primary Beam shield present (with interlocks) YES, shield locked so beam can only point at beam shield.

Emergency Procedures Posted YES.

Control Panel Lock YES

Emergency Shut OFF YES, on control console and in room on hand control and on side of treatment unit stand.

Indication that control console is ON YES, on control console, Above door to treatment room and on gantry head.

Indication that beam in ON YES, on control console, Above door to treatment room, and on gantry head.

Means provided for operator to terminate exposure at any time YES.

Timer terminates exposure YES.

Leak Test Performed YES, by THERATRONICS

Personnel monitored YES, by SIEMENS GAMMASONICS, INC.

Monitoring records INDICATE MINIMAL EXPOSURE to OPERATING PERSONNEL

Jennie Enola
Physicist

Operational Performance Evaluation Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave, Suite 116
West Plains, MO

Unit: AECL Theratron 780

Room Location: _____

Coincidence of the mechanical axis of the collimator assembly, the central axis of the light beam, and the cross hairs: OK

Coincidence of the light beam with the useful x-ray beam (acceptable: 1.5 mm) OK

Coincidence of light field, collimator dial setting, and x-ray beam sizes at the SAD or SSD distance (acceptable: agree within 1.5 mm) OK

Determination of the mechanical isocenter (acceptable: sphere of 2 mm) OK

Determination of the isocenter of the radiation beam

1) Collimation (acceptable: 1.5 mm in diameter circle) OK

2) Treatment table (acceptable: 1.5 mm in diameter circle) Treatment table has too much play, does not meet criteria when moved.

3) Gantry (acceptable: 2 mm diameter circle) OK

Timer: Accuracy and linearity OK, Timer delay of -0.017

SSD Indicators: Mechanical indicator within 1 mm @ 80 cm. Optical indicator within 2 mm for distances between 60-100 cm.

Beam Flatness (acceptable: Manufacture specifications - typically + 3% over central 80% of the largest field area at isocenter) OK, see scans

Beam Direction Dependence: Negligible, ±0.1%

Jennie Funke
Physicist

Percentage Depth Dose Data Check Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave Suite #116
West Plains, MO

Unit: AECL Theratron 780

Room Location: _____

Using NEL 2570 Dosimeter with NEL 2571 (#1063)

Field Size 6 X 6 SSD 80

Readings for 2.0 min at indicated depth in water phantom.

5 cm depth with reported % depth dose 76.2 %.

67.70 67.75 67.75 Ave. 67.73.

10 cm depth with reported % depth dose 52.5 %.

46.80 46.80 46.80 Ave. 46.80 .Cal. % D.D.* 52.7

15 cm depth with reported % depth dose 35.7 %. % Diff +0.4%

31.55 31.60 31.60 Ave. 31.58 .Cal. % D.D.* 35.5

% Diff -0.6%

Field size 10 X 10 SSD 80

Readings for 2.0 min at indicated depth in water phantom.

5 cm depth with reported % depth dose 78.8 %.

72.45 72.50 72.55 Ave. 72.50.

10 cm depth with reported % depth dose 56.4 %.

52.15 52.20 52.15 Ave. 52.17 .Cal. % D.D.* 56.7

15 cm depth with reported % depth dose 39.4 %. % Diff +0.5%

36.35 36.35 36.35 Ave. 36.35 .Cal. % D.D.* 39.5

% Diff +0.3%

Field size 20 X 20 SSD 80

Readings for 2.00 min at indicated depth in water phantom.

5cm depth with reported % depth dose 81.3 %.

79.35 79.35 79.35 Ave. 79.35.

10 cm depth with reported % depth dose 60.8 %.

59.50 59.55 59.55 Ave. 59.53 .Cal. %D.D.* 61.0

15 cm depth with reported % depth dose 44.5 %. % Diff +0.3%

43.40 43.40 43.45 Ave. 43.42 .Cal. % D.D.* 44.5

% Diff 0%

* The dose measured at 5 cm depth has been normalized to the reported depth dose for the field size and the corresponding depth doses at 10 and 15 cm calculated.

Dennis Fowler

Physicist

Percentage Depth Dose Data Check Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave Suite #116
West Plains, MO

Unit: AECL Theratron 780

Room Location:

Using NEL 2570 Dozemeter with NEL 2571 (#1063)

Field Size 6X6 SSD 80

Readings for 2.0 min at indicated depth in water phantom.

5 cm depth with reported % depth dose 76.2%.
67.70 67.75 67.75 Ave. 67.73.
10 cm depth with reported % depth dose 52.5%.
46.80 46.80 46.80 Ave. 46.80 .Cal. % D.D.* 52.7
15 cm depth with reported % depth dose 35.1%. % Diff +0.4%
31.55 31.60 31.60 Ave. 31.58 .Cal. % D.D.* 35.5
% Diff -0.6%

Field size 10X10 SSD 80

Readings for 2.0 min at indicated depth in water phantom.

5 cm depth with reported % depth dose 78.8%.
72.45 72.50 72.55 Ave. 72.50.
10 cm depth with reported % depth dose 56.4%.
52.15 52.20 52.15 Ave. 52.17 .Cal. % D.D.* 56.7
15 cm depth with reported % depth dose 39.4%. % Diff +0.5%
36.35 36.35 36.35 Ave. 36.35 .Cal. % D.D.* 39.5
% Diff +0.3%

Field size 20X20 SSD 80

Readings for 2.00 min at indicated depth in water phantom.

5cm depth with reported % depth dose 81.3%.
79.35 79.35 79.35 Ave. 79.35.
10 cm depth with reported % depth dose 60.8%.
59.50 59.55 59.55 Ave. 59.53 .Cal. %D.D.* 61.0
15 cm depth with reported % depth dose 44.5%. % Diff +0.3%
43.40 43.40 43.45 Ave. 43.42 .Cal. % D.D.* 44.5
% Diff 0%

* The dose measured at 5 cm depth has been normalized to the reported depth dose for the field size and the corresponding depth doses at 10 and 15 cm calculated.

Dennis Fowler
Physicist

Timer Evaluation

Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave, Suite 116
West Plains, MO

Unit: AECL Theratron 780

Room Location: _____

Timer Accuracy:

SET TIME	MEASURED TIME (with stop watch)		
0.5 min	30 3/100"	30 23/100"	30 19/100"
1.0	1' 00 17/100"	1' 00 15/100"	1' 00 21/100"
2.0	2' 00 23/100"	2' 00 21/100"	2' 00 17/100"

Comments:
Timer OK

Shutter Correction Evaluation

Technique: 10.0 x 10.0 cm Field, 80 cm SSD

Measurements at 5.0 cm depth in water

Measuring Instrument NEL FARMER 2570 Dosemeter with N= 2571 (#1063)

Readings for 0.5 setting
17.70 17.75 17.70 17.80 Ave. 17.74

Readings for 1.0 setting
36.15 36.10 36.15 Ave. 36.18

Readings for 2.0 setting
72.85 72.85 72.85 Ave. 72.85

Readings for 4 x 0.5 setting
~~70.85~~ 71.00 70.95 71.00 Ave. 70.98

Comments:

$f(1.00) = 36.14$ Linearity OK

$r = 1.00000$

Time Delay $= \frac{(72.85)(5) + (17.74)(2)}{72.85 - 17.74}$

$= 017$ min

Physicist

Beam Flatness Date: 3/25/94

Institution: Radiation Oncology Center
1115 Alaska Ave, Suite 116
West Plains, MO

Unit: AECL Theratron 780

Room Location: _____

Technique: 10 X 10 cm^2 and 20 X 20 cm^2 field, 80 cm SCD

Measurements at In Air with buildup cap

Measuring instrument EMI Radiation Field Scanner

Setting: Continous.

Cross Plane			In Plane		
Readings (-)	Location	Readings (+)	Readings (-)	Location	Readings (+)
See Scans			See Scans		

Comments: Flatness-OK

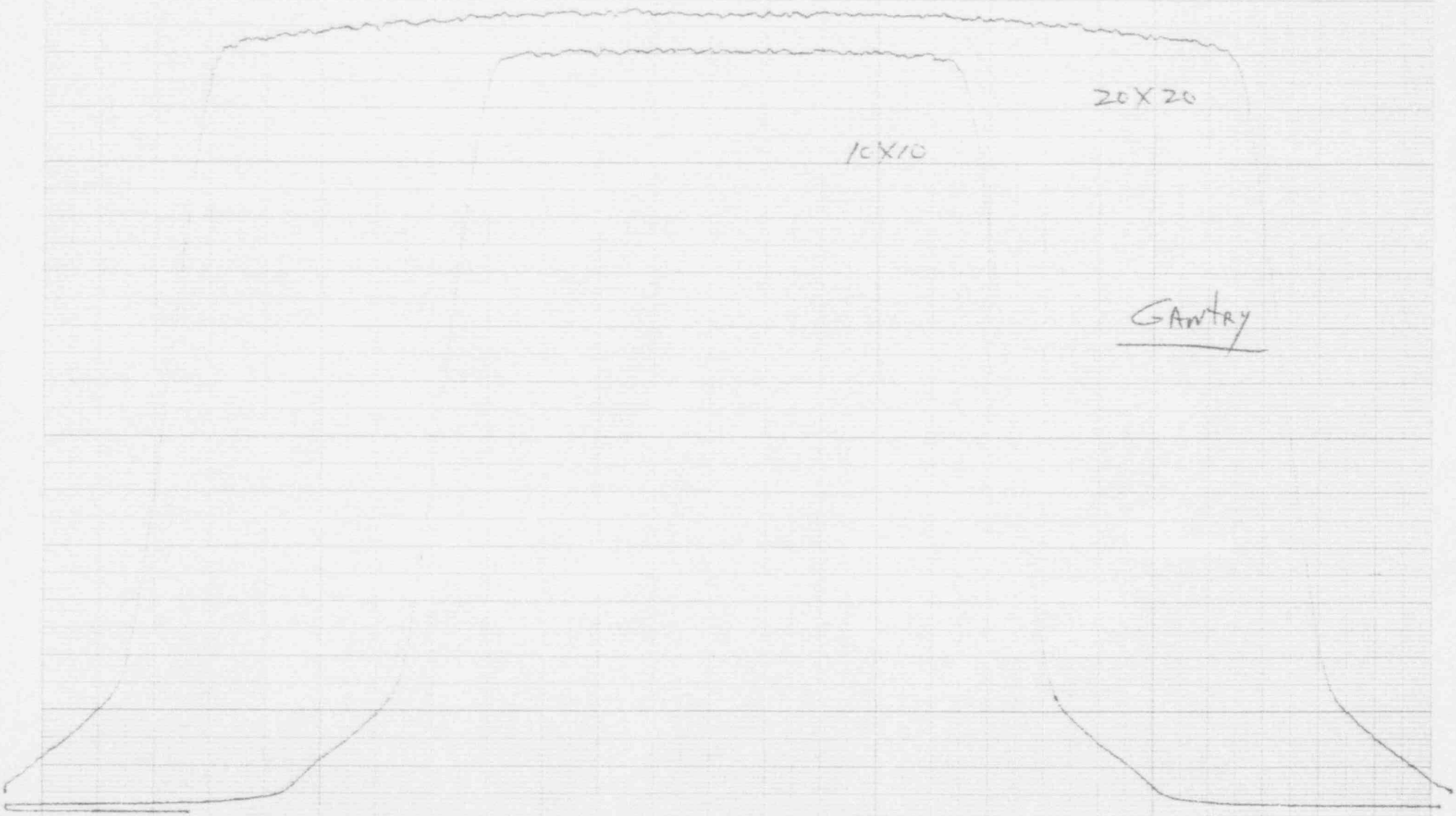
Jennifer Fuerte
Physicist

3/25/94

RADIATION ONCOLOGY CENTER, WEST PLAINS, MO

IN PLANE SCANS

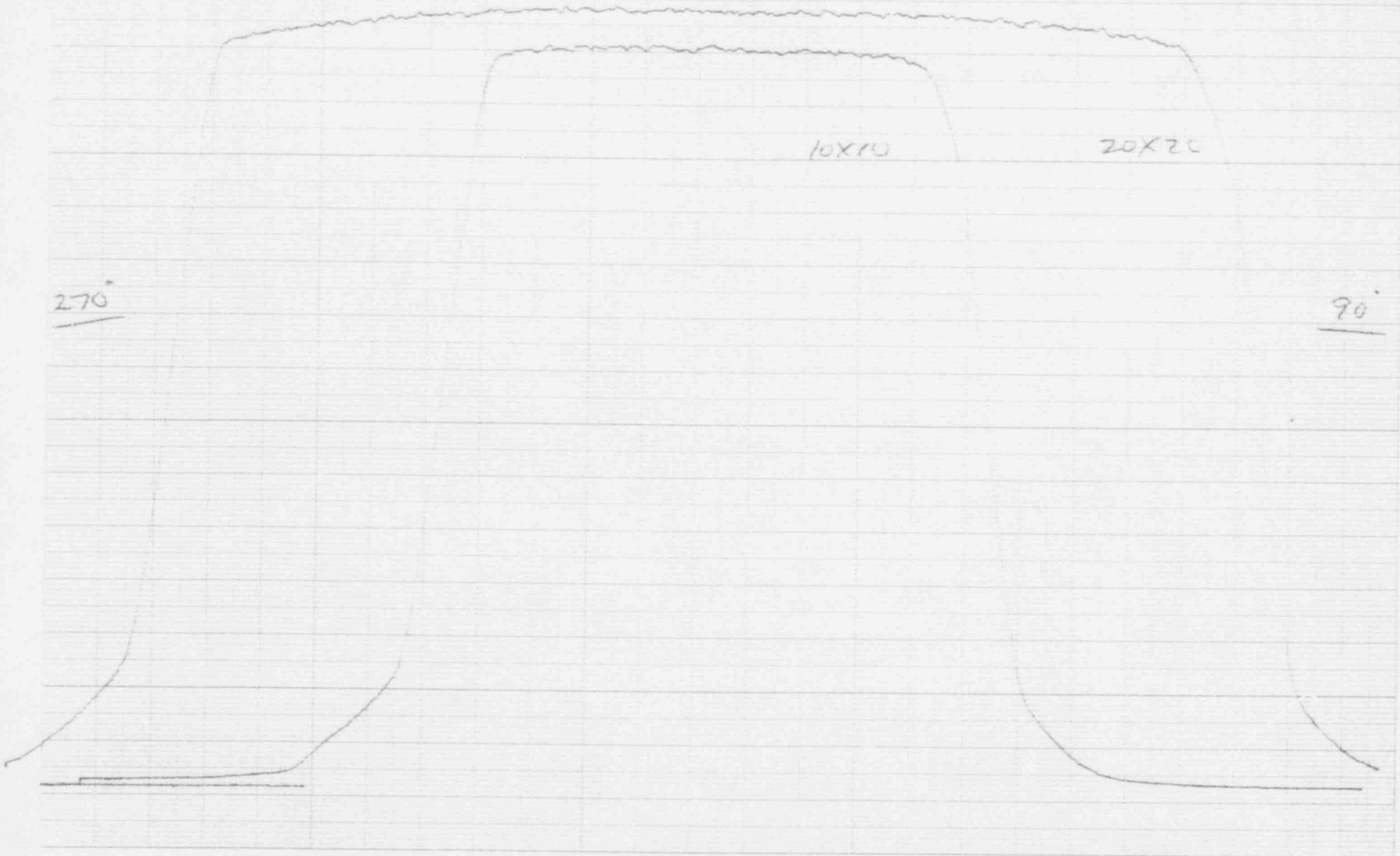
Co-60



3/25/94

Radiation Oncology Center, West Plains, MO Cross Plane Scans

Co-60



Calibrated Measurement of Peak Dose Rate for 10 cm Square Beam

Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave, Suite 116
West Plains, MO

Unit: AECL Theratron 780

Room Location: _____

Technique: 10 x 10 cm² field, 80 cm SSD

Measurements at: 5.0 cm depth in water

Measuring Instrument: NEL 2570 Dosemeter (#602) with NEL 2571 (#1063) chamber

Instrument Readings:

Setting:	2.0 min	4 x 0.50	V = 1/2 2.0 min
	72.25	70.35	72.10
	72.25	70.35	72.15
	72.25	70.35	72.10
	72.30		72.10
	72.20		72.15
Average =	72.25 nC	70.35 nC	72.12 nC

Expected 'true' reading for _____ $P_{ion} = \frac{3(72.12)}{4(72.12) - 72.25}$

End Error = $\left(\frac{70.35 - 72.25}{4(72.25) - 70.35}\right) 2.0 = -0.017$ min

Instrument Calibration factor (Roentgen per scale division) $P_{ion} = 1.0006$

N_x = 4727 x 10⁹ R/C $N_{gas}/(N_x \Lambda_{ion}) = 8.54 \times 10^{-3}$ Gy/R

Ambient Pressure = 726 $\Lambda_{ion} = 1.000$

Ambient Temperature = 193 $N_{gas} = 4.0369 \times 10^{7}$ Gy/C

% D.D. at 5.0 deep for 10 cm square beam = 78.8?

Other factors : $N_{tissue} = .99$

Peak Dose Rate:

$N_{meter} = 1.002$ (High)

Dennis Farrell

Physicist

Worksheet (2) for calculating the dose to water at d_{max} from photon beams

Name: DENNIS R. COA Date: 3/26/94

1. Radiation source: AECL THERATRON 780; Stated energy: Co-60 MeV
   Ionization ratio: — (Sec. IV B) Nominal accelerating potential: — (Fig. 3) MV
2. Phantom material (med): WATER SSD: 80 cm
   Collimator field size: 10 × 10 cm²; Depth of measurement: 5.0 cm

3.1. Dose to phantom material per monitor unit [Eq. (9)]:

$$D_{med}/U = (\overline{M/U})\, N_{gas} (\overline{L}/\rho)^{med}_{air} P_{wall} P_{ion} P_{repl},$$

where U refers to accelerator monitor units, or time for a ^{60}Co unit.

3.2. The chamber temperature T = 19.3 °C and pressure P = 726 mmHg at the time of measurement. The chamber signal M is normalized to 22 °C and 1 atmosphere using the factor:

$$\frac{T + 273\,°C}{295\,°C} \times \frac{760\ mmHg}{P} = 1.0390 \qquad N_{nn} = 1.002$$

3.3. Mean chamber signal per monitor unit (at the higher collecting potential, and normalized to 22 °C and 760 mmHg)

$$\left(\frac{72.25 \times 10^{-9}}{2.00 - 0.017}\right)(1.0390)(1.002) \quad (\overline{M/U}) = 3.7931 \times 10^{-8}\ C/\text{monitor unit}$$

or $(\overline{M/U})$ = _____ scale division/monitor unit

3.4. Cavity-gas calibration factor:
Chamber model: NEL 2571 (N_{1063}) Wall material: Graphite
Inner diameter: 6.3 mm Wall thickness: 0.065 g/cm²
N_{gas} = 4.0369×10^{7} Gy/C or Gy/scale division.

3.5. Stopping-power ratio (Fig. 2, Table IV): $(\overline{L}/\rho)^{med}_{air}$ = 1.134

3.6. Wall correction factor [Eq. (10)]:

$$P_{wall} = \frac{[\alpha(\overline{L}/\rho)^{wall}_{air}(\overline{\mu}_{en}/\rho)^{med}_{wall} + (1-\alpha)(\overline{L}/\rho)^{med}_{air}]}{(\overline{L}/\rho)^{med}_{air}} = 0.9969$$

Fraction of ionization from chamber wall (Fig. 7): α = 0.56

If $\alpha > 0.25$, enter α and $(1-\alpha)$. $(1-\alpha)$ = 0.44
If $\alpha < 0.25$, enter $\alpha = 0$ and proceed to 4.

Stopping-power ratio (Fig. 2, Table IV): $(\overline{L}/\rho)^{wall}_{air}$ = 1.012

Energy-absorption coefficient ratio (Table IX):

$(\overline{\mu}_{en}/\rho)^{med}_{air}$ 1.111 ÷ $(\overline{\mu}_{en}/\rho)^{wall}_{air}$ 0.997 = $(\overline{\mu}_{en}/\rho)^{med}_{wall}$ 1.1143

4. Ionization recombination correction (Sec. IV C and Fig. 4): P_{ion} = 1.006
5. Replacement (gradient) correction (Fig. 5): P_{repl} = 9913
6. Dose to phantom material per monitor unit or per unit time,[‖] at point of measurement: D_{med}/U = 1.7170 Gy/~~monitor~~ unit

7.1. Dose to water per monitor unit, at d_{max} [Eq. (17)]:

$$D_{water}(\text{at } d_{max})/U = \frac{(D_{med}/U) \times ESC \times (\overline{\mu}_{en}/\rho)^{water}_{med}}{P/100}$$

7.2. Correction for excess scatter from acrylic phantoms (Table XIV): ESC = —
7.3. Energy-absorption coefficient ratio (Table XII): $(\overline{\mu}_{en}/\rho)^{water}_{med}$ = —
7.4. Percent depth dose at depth of measurement: P = 78.8 %
7.5. Dose to water per monitor unit, at d_{max}: $D_{water}(\text{at } d_{max})/U$ = 2.1790 Gy/~~monitor~~ unit

D_{water} = 1.717 × .993 = 2.157 Gy/min = 215.7 RAD/min

[‖] Cobalt-60 units may have a nonlinear relationship between dose per unit time and time, especially for short exposure times. Corrections should be made using the method of Orton and Siebert (Ref. 58).

Calibrated Measurement of Peak Dose Rate for 10 cm Square Beam

Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave, Suite 111
West Plains, MO

Unit: AECL Theratron 780

Room Location: _____

Technique: 10×10 cm² field, 80 cm SSD

Measurements at: 5.0 cm depth in water

Measuring Instrument: NEL 2570 Dosemeter with NEL 2571 (#1063)
High Scale

Instrument Readings:

Setting:	2.00 min	4 × 0.50 min	2. chan
	72.85	71.00	72.75
	72.85	70.95	72.70
	72.85	71.00	72.75
	72.85	70.98 nC	72.73 nC
Average =	72.85 nC		

$V = V_2$

$P_{ion} = \frac{3(72.73)}{4(72.73) - 72.85}$

Expected 'true' reading for

End Error = $\left(\frac{70.98 - 72.85}{4(72.85) - 70.98}\right) 2 = -0.017$ min

$P_{ion} = 1.0006$

Instrument Calibration factor (Roentgen per scale division)

$N_x = 4.727 \times 10^9$ R/C $\quad N_{gas}/(N_x A_{min}) = 8.54 \times 10^{-3}$ Gy/R

Ambient Pressure = 733 $\quad A_{min} = 1.000$

Ambient Temperature = 20.1 $\quad N_{gas} = 4.0369\ 10^7$ Gy/C

% D.D. at 5 cm deep for 10 cm square beam = 78.87

Other factors : $K_{mmin} = .99$

Peak Dose Rate:

Jerry Fowler
Physicist

Worksheet (2) for calculating the dose to water at d_{max} from photon beams

Name: DENNIS FRIEDA Date: 3/26/94

1. Radiation source: AECL Theratron 780; Stated energy: Co-60 MeV
   Ionization ratio: _____ (Sec. IV B) Nominal accelerating potential: _____ MV (Fig. 3)
2. Phantom material (med): WATER SSD: 80 cm
   Collimator field size: 10 x 10 cm²; Depth of measurement: 5.0 cm
3.1. Dose to phantom material per monitor unit [Eq. (9)]:

$$D_{med}/U = (\overline{M/U})\, N_{gas} (\overline{L}/\rho)^{med}_{air} P_{wall} P_{ion} P_{repl}$$

where U refers to accelerator monitor units, or time for a ^{60}Co unit.

3.2. The chamber temperature T = 20.1 °C and pressure P = 733 mmHg at the time of measurement. The chamber signal M is normalized to 22 °C and 1 atmosphere using the factor:

$$\frac{T + 273\,^{\circ}C}{295\,^{\circ}C} \times \frac{760\ mmHg}{P} = 1.0302 \qquad N_{nn} = 1.002$$

3.3. Mean chamber signal per monitor unit (at the higher collecting potential, and normalized to 22 °C and 760 mmHg)

$$\left(\frac{72.85 \times 10^{-9}}{2.00 - 0.017}\right)(1.0302)(1.002) \quad (\overline{M/U}) = 3.7922 \times 10^{-5}\ C/\text{monitor unit}$$

or $(\overline{M/U})$ = _____ scale division/monitor unit

3.4. Cavity-gas calibration factor:
Chamber model: NE2571 (#1063) Wall material: Graphite
Inner diameter: 6.3 mm Wall thickness: 0.065 g/cm²
N_{gas} = 4.0369 x 10⁷ Gy/C or Gy/scale division.
$N_x = 4.727 \times 10^{9}$ R/C

3.5. Stopping-power ratio (Fig. 2, Table IV): $(\overline{L}/\rho)^{med}_{air}$ = 1.134

3.6. Wall correction factor [Eq. (10)]:

$$P_{wall} = \frac{[a(\overline{L}/\rho)^{wall}_{air}(\overline{\mu}_{en}/\rho)^{med}_{wall} + (1-a)(\overline{L}/\rho)^{med}_{air}]}{(\overline{L}/\rho)^{med}_{air}} = 0.9969$$

Fraction of ionization from chamber wall (Fig. 7): a = 0.56

If $a > 0.25$, enter a and $(1-a)$. $(1-a)$ = 0.44

If $a < 0.25$, enter $a = 0$ and proceed to 4.

Stopping-power ratio (Fig. 2, Table IV): $(\overline{L}/\rho)^{wall}_{air}$ = 1.017

Energy-absorption coefficient ratio (Table IX):

$(\overline{\mu}_{en}/\rho)^{med}_{air}$ 1.111 + $(\overline{\mu}_{en}/\rho)^{wall}_{air}$ 0.997 = $(\overline{\mu}_{en}/\rho)^{med}_{wall}$ 1.1143

4. Ionization recombination correction (Sec. IV C and Fig. 4): P_{ion} = 1.0006
5. Replacement (gradient) correction (Fig. 5): P_{repl} = .9913
6. Dose to phantom material per monitor unit or per unit time,[‖] at point of measurement: D_{med}/U = 1.7166 Gy/~~monitor~~ min unit
7.1. Dose to water per monitor unit, at d_{max} [Eq. (17)]:

$$D_{water}(\text{at } d_{max})/U = \frac{(D_{med}/U) \times ESC \times (\overline{\mu}_{en}/\rho)^{water}_{med}}{P/100}$$

7.2. Correction for excess scatter from acrylic phantoms (Table XIV): ESC = —
7.3. Energy-absorption coefficient ratio (Table XII): $(\overline{\mu}_{en}/\rho)^{water}_{med}$ = —
7.4. Percent depth dose at depth of measurement: P = 78.8 %
7.5. Dose to water per monitor unit, at d_{max}: $D_{water}(\text{at } d_{max})/U$ = 2.1785 Gy/~~monitor~~ min unit
Drive = Dwater x .99 = 2.157 Gy/minute = 215.7 cGy/min

[‖] Cobalt-60 units may have a nonlinear relationship between dose per unit time and time, especially for short exposure times. Corrections should be made using the method of Orton and Siebert (Ref. 58).

Dennis Frieda

Output Determination (Page 1) Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave, Suite 116
West Plains, MO

Unit: AECL Theratron 780

Location: _____

Technique: 80 cm SSD Measuring Instrument: NEL 2570 Dosemeter with NEL 2571 (#1063)

Measurements at: 5.0 cm depth in water

Beam Size square (a)	Instrument Readings for setting Time = 1.00 (b)	Mean (c)	Associated 10 cm square valve (d)	Ratio (e)	% DD at 5.0 / SSD for SSD (f)	Relative output (g)	Output Normalized to 10x10 (h)	Previous Norm output
10 X 10	35.85 35.85 35.90	35.87			78.8	1.2690	1.00	1.00
12 X 12	36.80 36.80 36.85	36.82	35.88	1.0262	79.5	1.2908	1.017	1.017
14 X 14	37.55 37.60 37.65	37.60	35.88	1.0479	80.0	1.3099	1.032	1.031
16 X 16	38.30 38.35 38.35	38.33	35.88	1.0683	80.5	1.3271	1.046	1.042
18 X 18	38.85 38.90 38.80 38.85	38.85	35.88	1.0828	80.9	1.3384	1.055	1.052
20 X 20	39.30 39.35 39.35	39.33	35.88	1.0962	81.3	1.3483	1.062	1.059

Dennis Trued

Output Determination (Page 2) Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave, Suite 116
West Plains, MO

Unit: AECL Theratron 780
Location: _____

Technique: 80 cm SSD Measuring Instrument: NEL 2570 Dosemeter with NEL 2571 (#1063)

Measurements at: 5.0 cm depth in water

Beam Size square (a)	Instrument Readings for setting Time = 1.00 (b)	Mean (c)	Associated 10 cm square valve (d)	Ratio (e)	% DD at 5.0 cm for SSD 80 cm (f)	Relative output (g)	Output Normalized to 10x10 (h)	Previous Norm. Output
10 x 10	35.85 35.92 35.90	35.88			78.5	1.2690	1.00	1.00
22x22	39.70 39.75 39.75	39.73	35.88	1.1073	81.5	1.3587	1.071	1.067
24x24	40.00 40.05 40.10	40.05	35.88	1.1162	81.6	1.3679	1.078	1.073
25x25	40.20 40.20 40.20	40.20	35.88	1.1204	81.7	1.3714	1.081	1.076
30x30	40.55 40.60 40.60	40.58	35.88	1.1310	82.1	1.3779	1.086	1.081
35x35	40.65 40.70 40.70	40.68	35.88	1.1338	82.4	1.3759	1.084	1.080

Dennis Tweed

Output Determination (Page 31)

Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave, Suite 116
West Plains, MO

Unit: AECL Theratron 780

Location: _____

Technique: 80 cm SSD

Measuring Instrument: NEL 2570 Dosemeter with NEL 2571 (#1063)

Measurements at: 5.0 cm depth in water

Beam Size square (a)	Instrument Readings for setting Time = 1.0 (b)	Mean (c)	Associated 10 cm square valve (d)	Ratio (e)	% DD at 5.0 / 80 for SSD (f)	Relative output (g)	Output Normalized to 10x10 (h)	Previous Normalized Output
10 X 10 Coll ∠ 180	35.85 35.90 35.90	35.88			78.8	1.2690	1.00	1.00
4.9 X 5.7 Coll ∠ 135°	32.90 32.95 32.90	32.92	35.90	.9170	75.5	1.2146	.957	.956
6 X 6 Coll ∠ 135	33.40 33.50 33.45	33.45	35.90	.9318	76.2	1.2228	.964	.966
7 X 7 Coll ∠ 135°	34.10 34.20 34.20	34.17	35.90	.9518	77.1	1.2345	.973	.973
8 X 8 Coll ∠ 135°	34.80 34.85 34.85	34.83	35.90	.9702	77.9	1.2470	.983	.983
9 X 9 Coll ∠ 135	35.45 35.40 35.45	35.43	35.90	.9869	78.3	1.2604	.993	.993
10 X 10 Coll ∠ 150	35.90 35.90 35.95	35.92						

Dennis Tuecke

30° WDG

Wedge Factor

Date: 3/26/94

Institution: RADIATION Oncology Center
1115 Alaska Ave// Suite 116
WEST PLAINS, MO

Unit: AECL THERATRON 780 (#86)

Room Location:

Wedge Description: Field: 10w X 15
SSD: 80
SDD: 45
Cat No. G22-151C

Technique: 8X13 cm² field, 80 cm SSD

Measurements at: 5.0 cm depth in water

Measuring Instrument: NEL 2570 Dosemeter with NEL 2571 (4063)

Setting: Set Time = 0.55

Collimator Angle	Readings Without Wedge	Readings With Wedge 30 Wedge Code:	
90	19.585	14.030	
90	19.620	14.065	
90	19.605	14.070	
270	19.560	13.885	
270	19.615	13.910	
270	19.605	13.910	
Average of Readings:	19.598	13.978	

Wedge Factor = $\frac{\text{Average of readings with wedge filter}}{\text{Average of readings without wedge filter}}$

$$WF_{30} = \frac{13.978}{19.598} = .713$$

Previous Wedge Factor: $PWF_{30} = 0.713$

[signature]
Physicist

45° WDG

Wedge Factor Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave / Suite 116
West Plains, MO

Unit: AECL Theratron 780

Room Location: _____

Wedge Description: Field: 10W x 15
SSD: 80 cm
SDD: 45 cm
Cat. No 622-152C

Technique: 8 x 13 cm² field, 80 cm SSD

Measurements at: 5.0 cm depth in water

Measuring Instrument: NEL 2570 Dosemeter with NEL 2571 (#1063)

Setting: Set Time = 0.55

Collimator Angle	Readings Without Wedge	Readings With Wedge 45° Wedge Code:	
90	19.555	11.420	
90	19.595	11.450	
90	19.610	11.445	
270	19.560	11.200	
270	19.615	11.230	
270	19.605	11.240	
Average of Readings:	19.590	11.331	

Wedge Factor = $\frac{\text{Average of readings with wedge filter}}{\text{Average of readings without wedge filter}}$

$$WF_{45} = \frac{11.331}{19.590} = .578$$

Previous Wedge Factor: $PWF_{45} = 0.578$

Jennifer Faucett
Physicist

60° WDC

Wedge Factor Date: 3/26/94

Institution: RADIATION ONCOLOGY CENTER
1115 ALASKA AVE. / SUITE 116
WEST PLAINS, MO

Unit: AECL THERATRON 780

Room Location:

Wedge Description: Field: 10 W x 15
SSD: 80 cm
SDD: 45
Cat No: 622-153C

Technique: 8 X 13 cm² field, 80 cm SSD

Measurements at: 5.0 cm depth IN WATER

Measuring Instrument: NEL 2570 DOSEMETER WITH NEL 2571 (#1663)

Setting: 1.00 mm

Collimator Angle	Readings Without Wedge	Readings With Wedge 60° Wedge Code:	
90	35.95	14.80	
90	35.95	14.80	
90	35.95	14.80	
270	35.90	14.80	
270	35.95	14.80	
270	35.95	14.80	
Average of Readings:	35.94	14.80	

Wedge Factor = $\frac{\text{Average of readings with wedge filter}}{\text{Average of readings without wedge filter}}$

$$WF = \frac{14.80}{35.94} = 0.412$$

Previous Wedge Factor: $PWF_w = 0.412$

Physicist

Tray Factor

Date: 3/26/94

Institution: Radiation Oncology Center
1115 Alaska Ave, Suite 116
West Plains, MO

Unit: AECL Theratron 780

Room Location: _____

Technique: 10X10 cm² fidd, 80 cm SSD

Measurements at 5.0 cm depth in water

Measuring Instrument: NEL 2570 Dosemeter (#602) with NEL 2571 (#1063)

Setting: Set Time = 1.00

Readings without Tray	Solid Acrylic Tray
35.80	35.80
35.85	35.85
35.80	35.85

without Tray Average 35.825

Readings with Tray Solid Acrylic Tray (~¼" thick)

TRAY #1	TRAY #2
34.40	34.20
34.40	34.25
34.40	34.25
34.40	34.23

with TRAY Average 34.32

Tray Factor = $\frac{\text{Average Reading with Tray}}{\text{Average Reading without Tray}}$

$$TF = \frac{34.32}{35.825} = .958$$

Previous Tray Factor: PTF = .958

Dennis Tweed
Physicist

Half-value Layer CERROBEND Date: 3/26/94

Institution: RADIATION ONCOLOGY CENTER
1115 ALASKA AVE, SUITE 116
WEST PLAINS, MO

Unit: AECL THERATRON 780

Room Location: _____

Technique: Co-60

kVp _____ mA _____ Filter _____

Measured with narrow beam geometry. 6 x 6 cm^2 field

Measuring Instrument: NEL 2570 DOSEMETER with NEL 2571 (#1063)

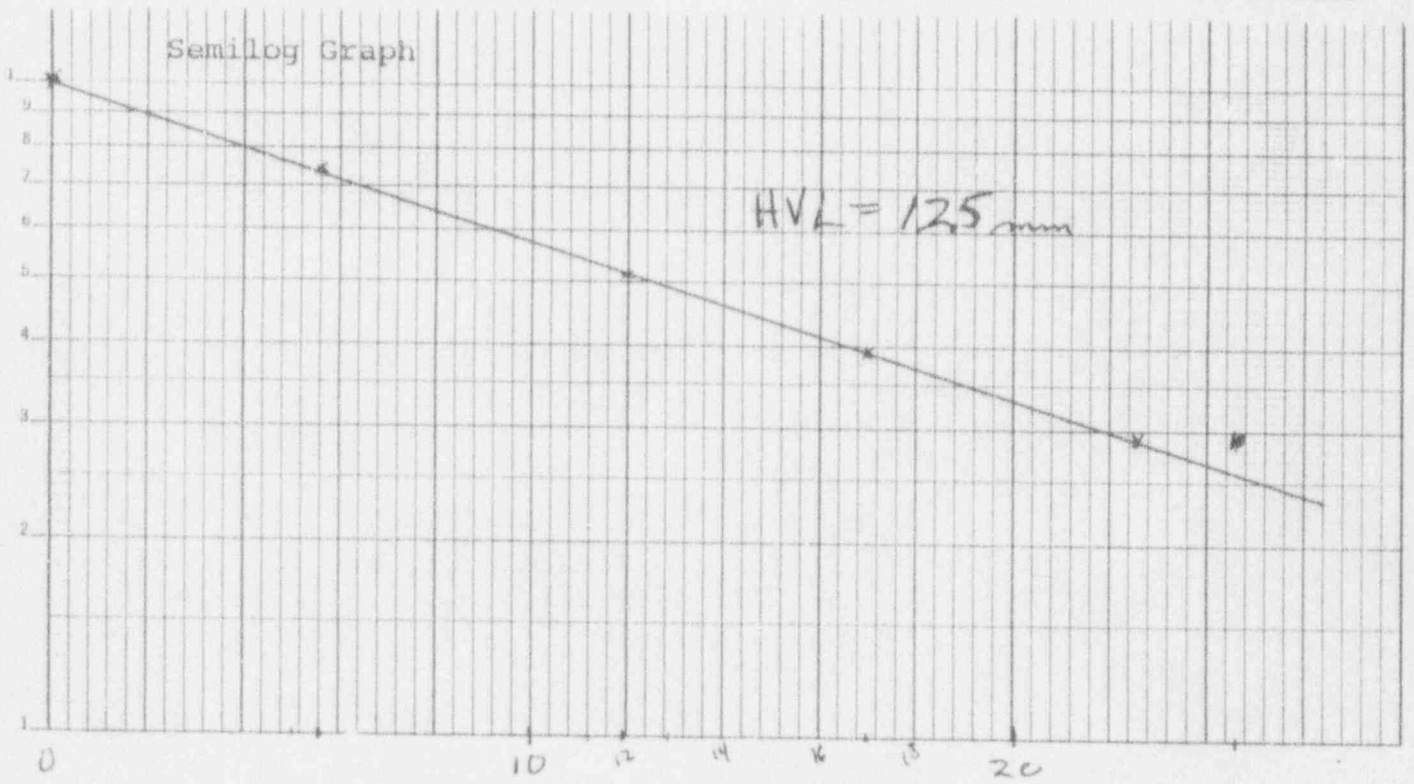
Readings with No added attenuators for time 1.00 min.
40.45 40.50 40.50 Ave. rate 40.48 Norm. 1.00

Reading with 5.6 mm added for time 1.00.
29.90 29.90 29.90 Ave. rate 29.90 Norm. 0.74

Readings with 11.9 mm added for time 1.00.
20.50 20.55 20.55 Ave. rate 20.53 Norm. 0.51

Readings with 17.0 mm added for time 1.00.
15.70 15.75 15.75 Ave. rate 15.73 Norm. 0.39

Readings with 22.6 mm added for time 1.00.
11.65 11.70 11.70 Ave. rate 11.68 Norm. 0.29



mm CERROBEND

Dennis Frush
Physicist

Beam Direction Dependence Date: 3/26/94

Institution Radiation Oncology Center
1115 Alaska Ave / Suite 116
West Plains, MO

Unit: AECL Theratron 780

Room Location: _____

Technique: 10x10 cm² field, 80 cm SCD with buildup cap

Measurement at Isocenter in Air

Measuring Instrument NEL 2570 Dosemeter with NEL 2571 (#1063)

Setting: 1.00 min

Head Angle	Reading (nC)
180 Pointed up	43.80
150	43.80
120	43.80
90	43.85
60	43.85
30	43.85
0° Pointed down	43.80
330	43.80
300	43.75
270	43.80
240	43.75
210	43.75

Comments: $\frac{43.85 - 43.75}{43.85 + 43.75} \times 100\% = \pm 0.1\%$

Physicist

Apparent Source Position

Date: 3/26/94

Unit: AECL THERATRON 780 Location: RADIATION ONCOLOGY CENTER, WEST PLAINS

Measuring Instrument: NEL 2570 DOSEMETER with NEL 2571 #1063 CHAMBER

Technique: ~~Ph~~ IN AIR with build-up CAP

Field Size at ____ cm. (cm.xcm)	Nominal Dist.	Temp. Pressure	Reading $T = 1.00$	Average Reading	Ave.rad. corrected for T-P	$\left(\text{Ave. Rad.}\right)^{-\frac{1}{2}}$ ~~Corrected For T-P~~	Apparent* Source Position
10x10 cm.	70	727 22.5	57.50 57.60 57.60	57.57		.13180	.67 cm r = .99998
	80	22.5 727	43.80 43.75 43.85	43.80		.15110	
	90	22.5 727	34.60 34.65 34.65	34.63		.16993	
	95	22.5 727	31.05 31.10 31.05	31.07		.17940	
Maximum Field 35 x 35	70	22.5 727	60.30 60.35 60.35	60.33		.12575	-0.56 cm r = 1.00000
	80	22.5 727	46.20 46.25 46.25	46.23		.14707	
	90	22.5 727	36.55 36.65 36.65	36.62		.16525	
	95	22.5 727	32.85 32.90 32.90	32.88		.17440	

* Apparent Source Position determined by least squares linear regression.

Notes: _____

Physicist

Co60 s position*

3/26/94

TREATMENT UNIT: **AECL 780**
ENERGY: **CO-60**
Field Size: **10X10**

SDD	READING	1/SQRT(READ.)	SQRT(Io/Ig)
70.0	57.57	0.1318	1.0000
80.0	43.80	0.1511	1.1465
90.0	34.63	0.1699	1.2894
95.0	31.07	0.1794	1.3612

Io= 57.5700

	Slope(m)	y-intercept(b)	Coefficient
SDD vs. 1/SQRT(Read.):	525.6137	0.6729	0.99997
SDD vs SQRT(Io/Ig):	69.2737	0.6729	0.99997

Field Size: **35X35**

SDD	READING	1/SQRT(READ.)	SQRT(Io/Ig)
70.0	60.33	0.1287	0.9769
80.0	46.23	0.1471	1.1159
90.0	36.62	0.1652	1.2538
95.0	32.88	0.1744	1.3232

Io= 57.5700

	Slope(m)	y-intercept(b)	Coefficient
SDD vs. 1/SQRT(Read.):	547.9433	-0.5600	1.00000
SDD vs SQRT(Io/Ig):	72.2167	-0.5600	1.00000

3/26/94

TREATMENT UNIT: AECL 780
ENERGY: CO-60
Field Size: 10X10

SCD	READING	Calculated Reading*	% Difference
70.0	57.5700	57.2082	0.6325
80.0	43.8000	43.8000	0.0000
90.0	34.6300	34.6074	0.0653
95.0	31.0700	31.0604	0.0309

TREATMENT UNIT: AECL 780
ENERGY: CO-60
Field Size: 35X35

SCD	READING	Calculated Reading*	% Difference
70.0	60.3300	60.3820	-0.0862
80.0	46.2300	46.2300	0.0000
90.0	36.6200	36.5274	0.2535
95.0	32.8800	32.7836	0.2940

* Calculated Reading is calculated by inverve square correction on the reading for 80 cm SCD.

Dose/Degree Calibration Date: 3/25/94

Institution RADIATION ONCOLOGY CENTER
1115 Alaska AVE, Suite 116
West Plains, MO

Unit: AECL THERATRON 780 (#86)

Room Location: _____

Technique: 10 X 10 cm² field

Dose/Degree Selector Setting	Arc length	Direction ~~Monitor Dose~~	Monitor Time	~~Dose/Degree~~ Degree/Minute
1.0	181	CCW	0.51	355
	181	CW	0.51	355
0.9	180	CCW	0.53	340
	182	CW	0.53	343
0.8	181	CCW	0.60	302
	217	CW	0.71	306
0.7	179	CCW	0.69	259
	180	CW	0.68	265
0.6	181	CCW	0.85	213
	180	CW	0.82	220
0.5	~~180~~ 181	CCW	1.09	166
	181	CW	1.05	172
0.4	181	CCW	1.50	121
	180	CW	1.41	128
0.3	181	CCW	2.37	76
	180	CW	2.15	84
0.2	180	CCW	5.43	33
	180	CW	4.28	42
0.1	Did not move after 1 minute			

By linear regression

CCW: $y = 0.00224x + 0.1266$ } for $0.3 \leq y \leq 0.9$

CW: $y = 0.00228x + 0.1053$

where x = Degree/Minute and y = Arm Speed Setting

Jennifer Lueke
Physicist

Rotational speed is not the same for CW vs. CCW motion. The gantry turns slightly faster in the CW direction for a given arm speed setting.

THE UNIVERSITY OF TEXAS
MD ANDERSON
CANCER CENTER

Accredited Dosimetry Calibration Laboratory — #94
(713) 792-3233

Instrument submitted by:

Dennis Frieda, Ph.D.
St John's Regional Health Center
Radiation Oncology - MACC
1235 E. Cherokee
Springfield, MO 65804

Report # 92-078

Report of Calibration

Date instrument received for calibration: September 14, 1992

Date Instrument calibration completed: September 23, 1992

Date calibration report mailed: October 2, 1992

Description of Instrument:

NEL Farmer Dosemeter Model 2570/AS2, Serial # 602
NEL Chamber Model 2571, (0.6 cc, graphite), Serial # 1063
Delrin Buildup Cap # 1063

NOTE: Proper function and reliability of the radiation measuring devices described in this document are highly dependent upon handling and use. Therefore, the duration of responsibility of The University of Texas M. D. Anderson Cancer Center, and its employees for the calibration results extends only to the time the instruments leave the M. D. Anderson Cancer Center premises. It is recommended that the instrument user establish an appropriate technique of monitoring the constancy of the instrument response before and after its submission to the Accredited Dosimetry Calibration Laboratory and on a regular basis thereafter. In addition, it is the express responsibility of the instrument user to assure himself (by personal communication, if necessary) that his interpretation of the information in this document is consistent with interpretation intended by the Accredited Dosimetry Calibration Laboratory.

CALIBRATION FACTORS:

Chamber Factors: Gy/C. This factor applies to the ion chamber alone. The calibration factors given in this report are quotients of the x-ray or gamma-ray air kerma in air and the charge generated by that radiation in the ionization chamber. The average charge used to compute the calibration factor is based on measurements with the wall of the ionization chamber at the stated polarity and potential. Leakage corrections were applied if necessary.

Electrometer Factors: C/rdg. This factor applies to the electrometer alone for the scale, switch setting and output mode specified. This factor is the quotient of the charge collected on the internal capacitor of the electrometer to the reading indicated on the display.

System Factor: Gy/rdg. This factor applies to chamber-electrometer readout systems as a unit with scale, switch setting and output mode specified. This factor is the quotient of x or gamma ray air kerma and the reading indicated on the display.

A system factor can be obtained by multiplying the chamber and electrometer factors.

$$Gy/rdg = (Gy/C)\ (C/rdg)$$

To obtain air kerma at the effective measurement point, in the absence of the chamber, the system factor is multiplied by the reading on the display corrected for temperature and pressure and ion collection efficiency (Pion). Some dosimetry systems may also need a non-linearity correction.

$$\text{Air Kerma} = (\text{rdg})\ (Gy/rdg)\ (TPC)\ (P_{ion})\ (\text{non-linearity correction})$$

As of May 1, 1989 the official radiation quantity for ion chamber calibrations used by the National Institute of Standards and Technology is air kerma in Gray (1 Gy = 1 J/kg). The AAPM (1983) calibration protocol uses calibration factors in units of exposure. This report gives calibration factors in both units (air kerma and exposure) to be compatible with both NIST and the AAPM protocol. Air Kerma is related to exposure as follows:

To obtain exposure in Roentgen, divide air kerma in Gray by:

8.79 x 10-3 Gy/R for cobalt 60 gamma rays
8.76 x 10-3 Gy/R for x-rays

ENVIRONMENTAL CONDITIONS:

Prior to calibration all chambers are tested to assure communication with the atmosphere. All chamber measurements were normalized to 760 millimeters of mercury and 22 degrees Celsius. Use of the chamber at other pressures and temperatures requires correction by the multiplicative factor:

$$(T + 273.15)/295.15 \times 760/P$$

where T is the temperature in degrees Celsius, and P is the chamber pressure in millimeters of mercury. No correction is made for the effect of water vapor on the instrument being calibrated since it is assumed that both the calibration and the use of the instrument take place in air with a relative humidity between 10% and 70%, where the humidity correction is nearly constant.

CALIBRATION CONDITIONS:

Field size is defined by the distance between the opposing 50-percent intensity lines, measured at the calibration distance, perpendicular to the center line of the calibration beam. Unless otherwise indicated, the calibration field size is 10 cm by 10 cm. Stem effect was not investigated; the calibration factor applies only to the field size stated.

During calibration, cylindrical or spherical chambers are centered in the beam with the stem perpendicular to the beam direction. The effective point of measurement is assumed to be the geometric center of the cavity. A parallel plate chamber is centered in the beam with the plates perpendicular to the beam direction. The effective point of measurement is assumed to be the inner surface of the entrance window at the center of the window. Manufacturer's markings are assumed to indicate this position.

All chambers (cylindrical, spherical or parallel plate) are calibrated by suspension free in space with no additional scattering material (other than adequate buildup for Cobalt-60).

BEAM QUALITY:

Medium energy x-ray beam quality is described in terms of the peak kilovoltage, the first half-value thickness in millimeters of aluminum and copper and the homogeneity coefficient (the ratio of the first and second half-value thickness). The half-value thicknesses were determined with a 2 cm diameter aperture and high purity aluminum and copper absorbers. The aperture and ion chamber were positioned at 50 cm and 100 cm, respectively, from the target.

X-Ray Beam Qualities Available

			BEAM QUALITY			
BEAM CODE	kVp	ADDED FILTERS (mm Al)	HVT (mm) (Al)	(CU)	HOMOGENEITY (Al)	(CU)
M1	75	0.2	2.04	0.066	66	60
M2	100	2.4	4.14	0.156	71	57
M3	125	4.0	6.03	0.268	74	54
M4	250	0.8 Thoreaus	17.8	2.92	98[a]	85

[a]Estimated.

ACCURACY:

The air kerma rate at the calibration position was measured with a transfer-quality ionization chamber which was calibrated at the National Institute of Standards and Technology. Electrometers are calibrated with a standard capacitor, regulated high voltage power supply and precision digital voltmeter all with calibrations traceable to NIST.

The precision of the calibration factors assigned by the Accredited Dosimetry Calibration Laboratory is believed to be within ±0.5% (cobalt-60) and ±1.0% (x-rays) of the current standards of NIST. The NIST states an overall uncertainty of 1% of which 0.7% is assigned to the uncertainty in the air kerma of their beam. The overall uncertainty is therefore, 1.2% for Cobalt-60 and 1.5% for x-rays. The overall uncertainty is considered to have the approximate significance of a 95% confidence limit.

The calibration factors is given to four digits to prevent rounding errors up to 0.5% when the first digit is unity.

COLLECTION EFFICIENCY:

The collection efficiency, Aion, under the conditions of calibration was determined on the cobalt 60 beam using the two voltage technique described by Almond (1981) for continuous radiation. The ratio of current (charge) produced in the chamber with the full polarizing voltage divided by that with 1/2 polarizing voltage was measured.

Ngas/(Nx Aion):

The AAPM calibration protocol converts the exposure calibration factor, N_X, into the cavity gas calibration factor, N_{gas}. This report provides the ratio $N_{gas}/(N_X A_{ion})$ for cylindrical chambers published by a Task Group of the ADCL's (Gastorf, 1986). For parallel plate pchambers, this ratio is calculated from the AAPM protocol guidelines using data by Nath & Schulz (1981).

References

1. Task Group 21, Radiation Therapy Committee, American Association of Physicists in Medicine: Medical Physics 10:742, 1983.

2. Almond, Peter R.: Medical Physics 8:901, 1981.

3. Gastorf, R., Humphries, L., and Rosenfeld, M.: Medical Physics 13:751, 1986.

4. Nath, R. and R. J. Schulz: Medical Physics 8:85, 1981.

ACCREDITED DOSIMETRY CALIBRATION LABORATORY
M. D. ANDERSON CANCER CENTER

Report of Chamber Calibration
Cobalt-60

INSTRUMENT:

NEL Chamber Model 2571, (0.6 cc, graphite), Serial # 1063
Delrin Buildup Cap # 1063

CALIBRATION CONDITIONS:

Chamber Only: Irradiated free in space with no additional scatter material (except for adequate buildup)

Preirrad. Leakage: -1×10^{-14} A

Orientation: Black line toward beam

Polarizing Voltage: -240 V (on thimble)

Ion collection efficiency (A_{ion})= 1.000

$N_{gas}/(N_X A_{ion}) = 8.54 \times 10^{-3}$ Gy/R

AIR KERMA

BEAM QUALITY	AIR KERMA RATE (Gy/min)	CALIBRATION* FACTOR (Gy/C)
Cobalt 60	0.28	4.155×10^7 Gy/C

EXPOSURE

BEAM QUALITY	EXPOSURE RATE (R/min)	CALIBRATION* FACTOR (R/C)
Cobalt 60	31	4.727×10^9 R/C

* At 22^0 C, 760 mm Hg

DATA BOOK: 27; PAGE(s): 224

William F Hanson 10/2/92
William F. Hanson DATE

ACCREDITED DOSIMETRY CALIBRATION LABORATORY
M. D. ANDERSON CANCER CENTER

Report of Electrometer Calibration
Electrometer Factor

St. John's Regional Health Center

Report # 92-078

INSTRUMENT:

NEL Farmer Dosemeter Model 2570/AS2, Serial # 602

SCALES, SWITCH POSITIONS, AND CONDITIONS:

Electrometer Switch:	Position
Function:	ON
Range:	see below
Chamber:	Charge (nC)

Chamber	Range	Calibration Factor C/RDG
Charge, nC	Low	1.001×10^{-9}
Charge, nC	High	1.002×10^{-9}

NOTE: Charge sensitivity (rdg/C) was constant to within ±0.1% or the precision of the reading (whichever is greater) over the range of readings from 4.050 to 20.240 on Charge, nC, Range: Low and 19.95 to 199.45 on Range: High. The calibration factors in this report may not be reliable outside this range.

DATA BOOK 29; PAGE(s): 77

William F. Hanson 10/2/92
William F. Hanson DATE

REPORT of TELETHERAPY SURVEY

Facility:

Radiation Oncology Center
Doctors' Pavilion
1115 Alaska Ave, Suite 116
West Plains, Missouri 65775

License number: **24-18733-02**

Surveyed By:

Dennis Frieda, Ph.D.
Radiological Physicist (ABR)
3135 East Redbud
Springfield, MO 65804

This is a report of surveys and tests performed on March 24-26, 1994, following the replacement of and installation of a new cobalt-60 source in the A.E.C.L. Theratron 780 Teletherapy unit, serial no. 86, located in the Radiation Oncology Center, West Plains, Missouri.

The unit had a new Cobalt-60 source, supplied by Theratronics International Limited, installed in it on March 24,1994. The new Cobalt-60 source, serial no. S-4714, is a 2.0 cm diameter standard source type C-146 with an initial activity of 295.5 TBq (7988 curies) on March 4, 1994. The unit is located in the Radiation Oncology Center, Doctors' Pavilion, 1115 Alaska Avenue, Suite 116, West Plains, Missouri, 65775, phone (417)257-7082. The unit is licensed under NRC license no. 24-18733-02 and under the supervision of Liep Tiong Tio, MD.

1. Report of Servicing and Inspection

   An "Inspection Certificate" signed by Theratronics Representative, D. Tegtmeyer, certifies that on March 24,1994, the source exposure mechanism in the above unit was fully inspected and serviced in accordance with U.S. Nuclear Regulatory Commission License No. 54-28315-01.

2. Leak Tests

   A. Leak Test Certificate issued by Theratronics indicates the source itself had a Dry Wipe Test performed on March 15, 1994. The results of these tests were negative indicating that removable activity was less than 0.005 microcuries.

B. Multiple wipe tests of the source portal and collimator surfaces were performed by the Theratronics service representative on March 24, 1994, following the installation of the source. Results of their analysis indicate the source is not leaking.

3. Beam Off Head Leakage

The beam off head leakage was measured at points on the surface of an imaginary sphere with a radius of one meter from the source. Measurements were made following installation of the new source by Theratronics service representatives on March 24, 1994. Measurements were made using a model RATO F, Berthold type survey meter last calibrated on January 28, 1994. The average of 18 points measured in their report was 1.13 mR/hr with a maximum reading of 2.85 mR/hr.

4. Interlocks

A. Interlocks are provided such that the beam cannot be turned on if the door is open. If the door to the treatment room is opened while the beam is ON, the source will automatically return to the OFF position and cannot be turned ON until reset at the control console.

B. The unit is equipped with a beamstop. A headlock is provided such that the source port can only be directed at the beam stopper.

5. Warning Devices and Emergency Plans

A. Lights are located on the control console, above the door to the treatment room and in the treatment room on the gantry head that indicate when the control console in ON and when the source is in the ON position.

B. An independent radiation monitor (Primalert) is provided in the treatment room that emits a flashing red light that can be seen from the treatment room entrance when the source is ON. The monitor is provided with a working battery back-up. Procedures call for the function of the monitor to be checked daily.

C. The door to the teletherapy treatment room is posted with a "Grave Danger – Very High Radiation Area" and a "Caution – Radioactive Materials" sign.

D. Emergency plans are posted near the control console noting what action is necessary if the source fails to retract.

D. Emergency plans are posted near the control console noting what action is necessary if the source fails to retract.

6. Radiation Field vs Light Field

A. Coincidence of the light field with the radiation field was demonstrated with film.

B. Studies with film showed no change in coincidence of the radiation and light fields with collimator rotation.

7. Output and Calibration

A. The Certificate of Measurement from Theratronics, specifies that the exposure rate in air of the source when installed will be 150.7 Rmm (±5%) for maximum field size. Measurements on March 26, 1994, found an exposure rate in air of 149.4 Rmm for maximum field size.

B. A full calibration of the unit was also performed on March 25-26, 1994. Using calculation methods of AAPM Protocol Task Group 21 (Dec.,'83), the dose rate at d_{max} for a 10X10 field with full backscatter at a source-to-surface distance of 80 centimeters was found to be 215.7 cGy/minute. See Calibration Report for further details.

8. Timer

A. The timer accuracy was measured with a stop watch. Both timer accuracy and linearity were found to be satisfactory over the useful clinical range.

B. The source was found to exhibit a timer delay of -0.017 minute. Thus 0.017 minute should be added to the calculated timer setting for each OFF-ON-OFF movement of the source.

9. Radiation Protection Survey Measurements

The cobalt teletherapy room is located on a grade such that it is partially buried underground. The unit also has a locked beam stopper to serve as a primary barrier. The floor is a primary/secondary barrier on grade. The east wall and the roof area are the only accessible primary/secondary barriers. All other accessible side wall areas are secondary barriers. All areas outside the treatment room were considered uncontrolled areas for the purpose of this report.

It is assumed the maximum workload of the unit is 20 patients per day, with each patient receiving approximately 400 cGy at 80 centimeters. The treatment unit has actually rarely treated over 10 patients per week since opening in 1986. Twenty patients per week would give a workload of 40,000 cGy per week at 80 centimeters. Using the current calibration, this gives a maximum weekly beam on time of less than 3.5 hours per week or alternatively, 0.7 hours per day.

The survey was conducted using a Ludlum 14C Survey Meter, serial no. 45115, with a model 44-6 probe, serial no. PR030949. This meter was last calibrated by Radiation Consultants of Mid-America, Inc, on February 15, 1994. All measurements were made using the maximum field size (35 cm X 35 cm), and with (for secondary barrier) and without (for primary barrier) a full water phantom (40 cm X 40 cm X 30 cm) for scatter. All measurements were made at one foot from the barriers. Measurements were taken at a wide variety of gantry positions in order to find the maximum for each area.

Summary of Exposure Measurements

Location (See Map) Location	As Primary Barrier (mRem/hr)	Maximum Reading as Secondary Barrier (mRem/hr)
1. Control Area South Wall	-	<0.05
2. Darkroom South Wall	<0.05	<0.05
3. Waiting Room SE Wall	<0.05	<0.05
4. East Wall (Outside)	<0.05	<0.05
5. North Wall (Outside)	-	<0.05
6. Roof (Outside)	1.7	2.9

See attached map showing survey locations.

From these measurements the only area of possible concern is the roof area. The roof area is raised approximately one and a half feet above grade. It is accessible only from the west. Using the workload discussed earlier, with the beam on only 0.7 hour per day, one could

not expect anyone to get 2 mR in any one hour. Using 10 CFR 20.1302(b)(1) to show compliance with dose limits, with this area being a remote outside area behind the hospital it is very reasonable to assign this area an occupancy factor of 1/8. Then the total maximum yearly dose to individual members of the public could be calculated as:

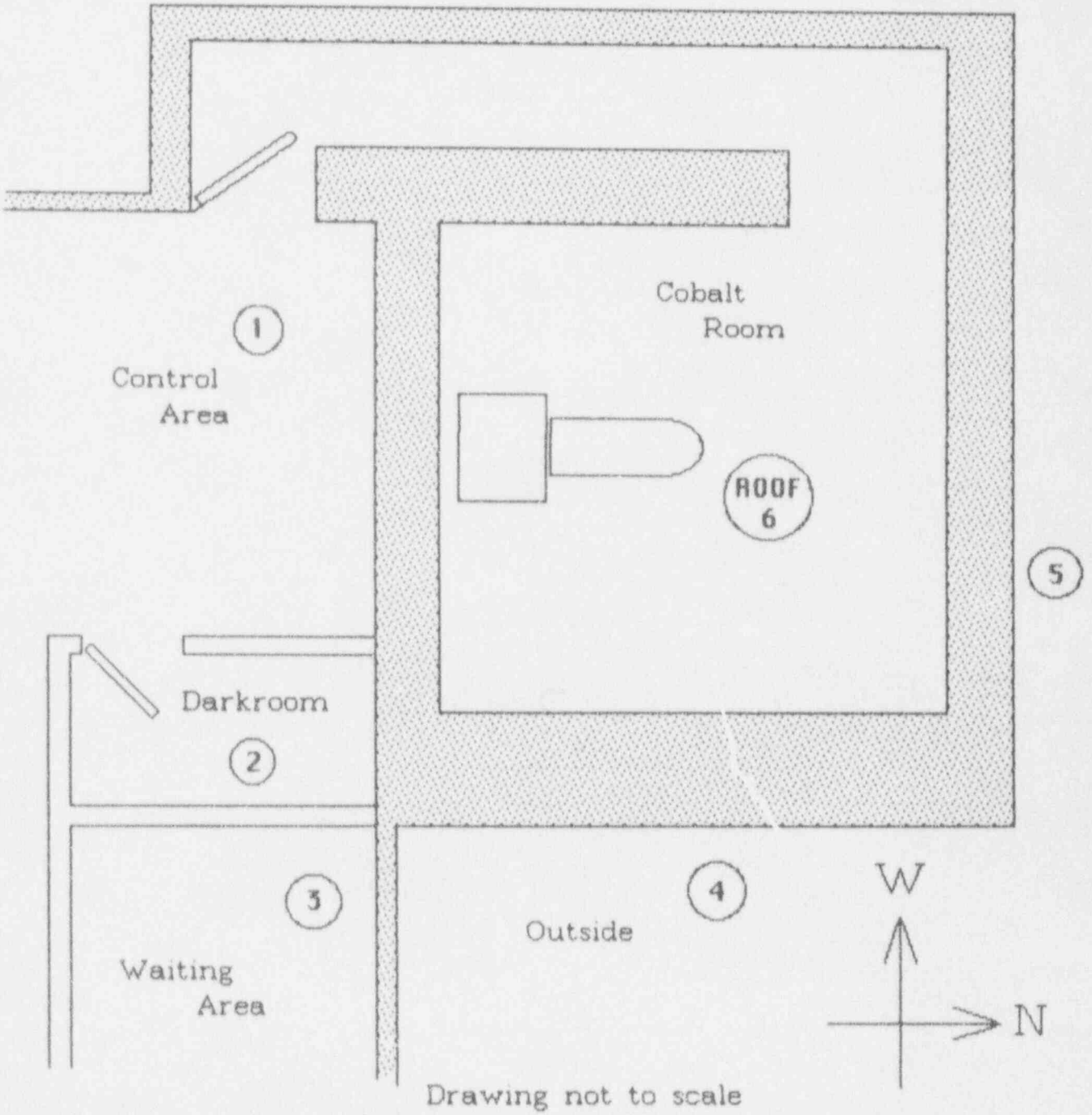
$$(3.5\ \text{hr/wk})*(52\ \text{Wk/yr})*(2.9\ \text{mrem/hr})(0.125) = 66\ \text{mrem/yr or } 0.066\ \text{rem/yr}$$

This does not exceed 0.1 rem (ie. 100 mrem) dose limit. The treatment unit is adequately shielded to meet the requirements of 10 CFR 20.

Dennis Frieda, Ph.D.
Radiological Physicist (ABR)

Radiation Oncology Center
Doctors' Pavilion
1115 Alaska Ave, Suite 116
West Plains, Missouri

Below Grade



Drawing not to scale

THERATRONICS

RADIATION SURVEY REPORT

Teletherapy Head - Beam Off

P&S 45956

CUSTOMER RADIATION ONCOLOGY CTR., OZARKS MEDICAL CTR.

LOCATION 1115 ALASKA AVE., WEST PLAINS, MO. 65775

TELETHERAPY UNIT MODEL THERATRON 780 SERIAL NUMBER 86

SOURCE DATA

Source Serial No. 5-4714 Diameter 2.0 cm TBq 295.5 Curies 7988

Measured Output 131.8 Rmm(ICRU) Measurement Date MAR 4, 94

Maximum Unit Output 150.7 Rmm Rated Capacity _____ Rmm(ICRU)

Survey Meter Type BERTHOLD Model RATO F.

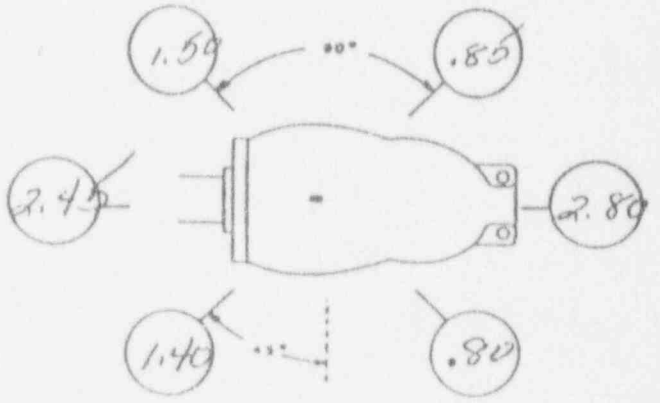
Survey Meter Serial No. 574258 Calibration Date JAN. 28, 94

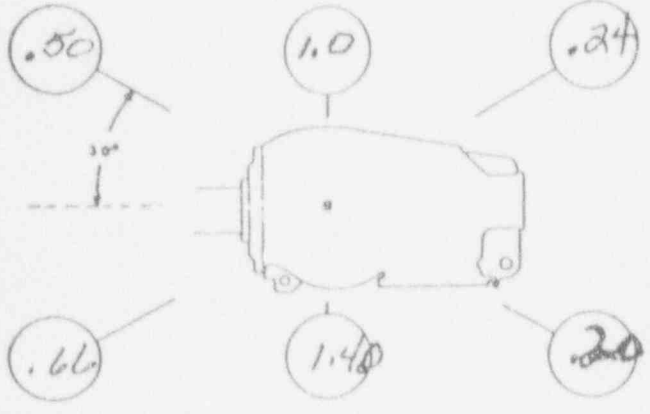
Head Survey Performed By TEGTMEYER / NOWAKOWSKI Date 24 MAR. 94

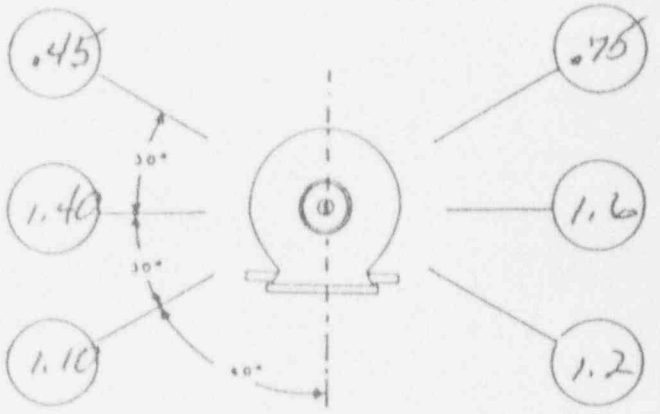
Theratronics Service Representative

NOTES

1. Perform survey with A.B.S. covers installed.
2. Values at each point are averaged over a 100 cm^2 area in accord with recommendations NCRP Report 33.
3. Values are in mR/h at 1 metre from the source.
4. This report is based on values measured at 18 points and is it is for compliance verification only. Report is not to be used as a substitute for comprehensive 26 point survey originally performed under controlled conditions at the factory in accordance with the recommendations of ICRP Report 15.
5. Average of values at all 26 points is equal to, or less than 2mR/h.
6. No measured value exceeds 10 mR/h.
7. Rmm Stands for Roentgens per minute at 1 meter







White - Customer
Yellow - Ottawa Unit History File

Pink - U.S. Service / Agent
White - U.S. Service / Agent

252A

THERATRONICS

CERTIFICATE OF MEASUREMENT

of

TELETHERAPY SOURCE S-4714

for

Customer: RADIATION ONCOLOGY CENTER
WEST PLAINS, MISSOURI

Order No.: P&S 45956

Therapy Unit Output: When installed in THERATRON 780 #86 (at maximum field size) the exposure rate will be 150.7 Rmm (±5%) based on the source measurement (below) , and the equipment conversion ratio described on sheet 264A.

Measurement of Source: Source S-4714 is a 2.0 cm diameter standard source type C-146 containing 295.5 TBq (7988 Curies) of cobalt 60. The source exposure rate was 131.8 Rmm (±3%) at the one meter position of the measurement cell.

Date of Measurement: 1994 March 4

Measurement Method

The source exposure rate was measured in the cell described on Form 263A "Measurement Cell for Teletherapy Sources". The exposure rate was measured with an air wall cavity ionization chamber having a volume of 0.6 cm^3 and fitted with a 4.6 mm lucite equilibrium cap. The instrument is calibrated in a cobalt-60 exposure rate certified by the National Research Council of Canada.

Accuracy

The uncertainty in the source exposure rate applies only to measurement of this source in the Measurement Cell. It represents the maximum total uncertainty due to all causes including the calibration of the Council's primary exposure rate, the calibration of their instrumentation and the precision of measurement in the Measurement Cell. Additional uncertainty due to the comparative measurements involved, has been included in the statement of unit output.

EXCERPT FROM THE RECOMMENDATIONS OF THE INTERNATIONAL COMMISSION ON RADIATION UNITS & MEASUREMENTS, REPORT ICRU-18, OCTOBER 1970. "It must be emphasized the measurement of exposure rate and/or absorbed dose for treatment purposes should be made locally by the user himself. The statement of equipment conversion ratio by the manufacturer should not be regarded as a substitute for this."

* RMM stands for Roentgens per Minute at one Meter

Issued 1994 March 10

Approved William Allin W.D.Allin
Measurement

J.L.Norton
Authorization

Theratronics International Limited • 413 March Road • PO Box 13140 • Kanata Ontario K2K 2B7
(613) 591-2100 • Fax (613) 592-3816 • Telex 053-4416

White - Customer
Yellow - Central Records
Pink - Unit History File
Gold - Cobalt Operations

THERATRONICS

LEAK TEST CERTIFICATE

Order No. P.S. 45956 THERATRON 780 #86 Date 1994 MARCH 15

Description of Source(s) Tested

One Cobalt-60 Teletherapy Source 2.0 CM. Active Diameter, Type C -146

Serial No. S-4714 Other

Leak Tests Performed **Results of Tests**

[X] 1. The Dry Wipe Test, Procedure DG-0065 NEGATIVE

Abstract – The surface of the capsule is thoroughly wiped with a filter paper. The paper is monitored and the amount of radioactive material present is determined. If less that 0.0005 microcuries are present, the results are described as negative. The limit is raised to 0.005 microcuries on the inner capsule of a double encapsuled assembly. The source assembly is retested after a minimum period of 7 days of storage and within 7 days of final packaging. The limit on the 7 days leak test is 0.005 microcuries.

[ ] 2. Other Tests (as described below)

1994 MARCH 15
Date of Completion of Tests

G.B. DUNCAN
Authorization

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285A

THERATRONICS

REPORT OF ROUTINE WIPE TEST FOR CONTAMINATION

P & S # 45956

IMPORTANT: Sources shall be tested for leakage at intervals not to exceed six months. Records of test results shall be kept in S.I. units or microcuries and maintained for inspection by the appropriate Licensing Authority.

LOCATION: OZARK MED CTR MODEL & SERIAL NO. T 780 # 86

115 ALASKA AVE W. PLAINS MO 65775 DATE OF TEST(S): 24 MARCH 94

TESTED FOR: ^{60}Co ☑ ^{238}U ☐

Drawer Tube in Head ☑ Collimator ☐ Source Container ☐ Other: BORE ☐

COMMENTS

Survey Meter Used: Berthold RATO/F Serial No. 574258 Calibration Date: 28 JAN 94

Berthold LB1200 Serial No. N/A Calibration Date: N/A

INSTRUMENT SENSITIVITY FACTORS					
Berthold RATO/F (Window Open)			Berthold LB1200 (Window Open)		
A	B		A	B	
40 c/min	= 0.005 µCi ^{60}Co	☑	110 c/min	= 0.005 µCi ^{60}Co	☐
140 c/min	= 0.005 µCi ^{238}U	☐	1500 c/min	= 0.005 µCi ^{238}U	☐

Leak Test(s) Performed:

☒ 1. Routine wipe contamination test as detailed in the Maintenance Manual or spec. #DG 0573 as found in the Source Handler's Handbook.

(Wipe Reading 22 c/min) - (Background Reading 22 c/min) = Net Reading 0 c/min.

Contamination = Net Reading 0 c/min x $\frac{\text{(B) } 0.005 \text{ µCi}}{\text{(A) } 40 \text{ c/min}}$ = 0 µCi

NOTE: B and A are the instrument sensitivity factors listed above.

Conversion to S.I. Units
0.001 µCi = 37Bq
0.005 µCi = 185Bq

Test Evaluations:

☒ NEGATIVE Test showed less than reportable limit.

☐ POSITIVE A written contamination report will be prepared to provide initial corrective action and details.

It is hereby certified that the test(s) indicated above have been carried out by/or under the supervision of the undersigned.

D. Yetmgau Mar. 25, 94 Svc. Rep.

Signed Date Title

Theratronics International Limited • 413 March Road • PO Box 13140 • Kanata Ontario K2K 2B7
(613) 591-2100 • Fax (613) 592-3816 • Telex 053-4416

White - Customer; Yellow - Unit History File; Pink - U.S. Service Agent

Form 257 Rev B

2/1'd

JAN 28 '94 11:38

THERATRONICS

P & S # 45956

IMPORTANT: Sources shall be tested for leakage at intervals not to exceed six months. Records of test results shall be kept in S.I. units or microcuries and maintained for inspection by the appropriate Licensing Authority.

LOCATION: OZARK MED CTR MODEL & SERIAL NO. T780 # 86

115 ALASKA AVE W. RAINS, MO 65775 DATE OF TEST(S): 24 MARCH 94

TESTED FOR: ^{60}Co ☒ ^{238}U ☐

Drawer Tube in Head ☐ Collimator ☐ Source Container ☐ Other: BORE ☐

COMMENTS

Survey Meter Used: Berthold RATO/F Serial No. 574258 Calibration Date: 28 JAN 94

Berthold LB1200 Serial No. N/A Calibration Date: N/A

INSTRUMENT SENSITIVITY FACTORS					
Berthold RATO/F (Window Open)			Berthold LB1200 (Window Open)		
A	B		A	B	
40 c/min	= 0.005 µCi ^{60}Co	☒	110 c/min	= 0.005 µCi ^{60}Co	☐
140 c/min	= 0.005 µCi ^{238}U	☐	1500 c/min	= 0.005 µCi ^{238}U	☐

Leak Test(s) Performed:

☒ 1. Routine wipe contamination test as detailed in the Maintenance Manual or spec. #DG 0573 as found in the Source Handler's Handbook.

(Wipe Reading 22 c/min) - (Background Reading 22 c/min) = Net Reading 0 c/min.

Contamination = Net Reading 0 c/min x $\frac{\text{(B) } 0.005 \text{ µCi}}{\text{(A) } 40 \text{ c/min}}$ = 0 µCi

NOTE: B and A are the instrument sensitivity factors listed above.

Conversion to S.I. Units
0.001 µCi = 37Bq
0.005 µCi = 185Bq

Test Evaluations:

☒ NEGATIVE Test showed less than reportable limit.

☐ POSITIVE A written contamination report will be prepared to provide initial corrective action and details.

It is hereby certified that the test(s) indicated above have been carried out by/or under the supervision of the undersigned.

D. Applegate Mar. 25, 94 Svc. Rep.

Signed Date Title

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(613) 591-2100 • Fax (613) 592-3816 • Telex 053-4416

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Form 257 Rev B

2/1 'd

JAN 28 '94 11:38

P & S # 45956

IMPORTANT: Sources shall be tested for leakage at intervals not to exceed six months. Records of test results shall be kept in S.I. units or microcuries and maintained for inspection by the appropriate Licensing Authority.

LOCATION: OZARK MED CTR MODEL & SERIAL NO. T780 2nd 86

HWY ALASKA AVE W. PLAINS, MO. DATE OF TEST(S): 24 MARCH 94

TESTED FOR: ^{60}Co ☒ ^{238}U ☐ 65775

Drawer Tube in Head ☐ Collimator ☐ Source Container ☐ Other: BORE ☑

COMMENTS

Survey Meter Used: Berthold RATO/F Serial No. 574258 Calibration Date 28 JAN 94

Berthold LB1200 Serial No. N/A Calibration Date: N/A

INSTRUMENT SENSITIVITY FACTORS					
Berthold RATO/F (Window Open)			Berthold LB1200 (Window Open)		
A	B		A	B	
40 c/min	= 0.005 µCi ^{60}Co	☒	110 c/min	= 0.005 µCi ^{60}Co	☐
140 c/min	= 0.005 µCi ^{238}U	☐	1500 c/min	= 0.005 µCi ^{238}U	☐

Leak Test(s) Performed:

☒ 1. Routine wipe contamination test as detailed in the Maintenance Manual or spec. #DG 0573 as found in the Source Handler's Handbook.

(Wipe Reading 22 c/min) - (Background Reading 22 c/min) = Net Reading 0 c/min.

Contamination = Net Reading 0 c/min x $\frac{\text{(B) } 0.005\ \mu\text{Ci}}{\text{(A) } 40\ \text{c/min}}$ = 0 µCi

NOTE: B and A are the instrument sensitivity factors listed above.

Conversion to S.I. Units
0.001 µCi = 37Bq
0.005 µCi = 185Bq

Test Evaluations:

☒ NEGATIVE Test showed less than reportable limit.

☐ POSITIVE A written contamination report will be prepared to provide initial corrective action and details.

It is hereby certified that the test(s) indicated above have been carried out by/or under the supervision of the undersigned.

D. Hoffmeyer Mar. 25, 94 Ser. Rep.

Signed Date Title

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Form 257 Rev B

2/1 d

JAN 28 '94 11:38

THERATRONICS **REPORT OF ROUTINE WIPE TEST FOR CONTAMINATION**

P&S # 45956

IMPORTANT: Sources shall be tested for leakage at intervals not to exceed six months. Records of test results shall be kept in S.I. units or microcuries and maintained for inspection by the appropriate Licensing Authority.

LOCATION: OZARK MED CTR MODEL & SERIAL NO. T 780 # 86

1115 ALASKA AVE W. PLAINS, MO DATE OF TEST(S): 24 MARCH 94

65775

TESTED FOR: ^{60}Co ☒ ^{235}U ☐

Drawer Tube in Head ☐ Collimator ☐ Source Container ☒ Other: _____ ☐

COMMENTS _____

Survey Meter Used: Berthold RATO/F Serial No. 574258 Calibration Date: 28 JAN 94

Berthold LB1200 Serial No. N/A Calibration Date: N/A

INSTRUMENT SENSITIVITY FACTORS					
Berthold RATO/F (Window Open)			Berthold LB1200 (Window Open)		
A	B		A	B	
40 c/min	= 0.005 µCi ^{60}Co	☒	110 c/min	= 0.005 µCi ^{60}Co	☐
140 c/min	= 0.005 µCi ^{235}U	☐	1500 c/min	= 0.005 µCi ^{235}U	☐

Leak Test(s) Performed:

☒ 1. Routine wipe contamination test as detailed in the Maintenance Manual or spec. #DG 0573 as found in the Source Handler's Handbook.

(Wipe Reading 22 c/min) - (Background Reading 22 c/min) = Net Reading 0 c/min.

Contamination = Net Reading 0 c/min x $\frac{\text{(B) } 0.005 \text{ µCi}}{\text{(A) } 40 \text{ c/min}}$ = 0 µCi

NOTE: B and A are the instrument sensitivity factors listed above.

Conversion to S.I. Units
0.001 µCi = 37Bq
0.005 µCi = 185Bq

Test Evaluations:

☒ NEGATIVE Test showed less than reportable limit.

☐ POSITIVE A written contamination report will be prepared to provide initial corrective action and details.

It is hereby certified that the test(s) indicated above have been carried out by/or under the supervision of the undersigned.

R. Vantuyne Mar. 25, 94 Svc. Rep.

Signed Date Title

Theratronics International Limited • 413 March Road • PO Box 13140 • Kanata Ontario K2K 2B7
(613) 591-2100 • Fax (613) 592-3816 • Telex 053 4416

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Form 257

Rev B

P&S# 45956

IMPORTANT: Sources shall be tested for leakage at intervals not to exceed six months. Records of test results shall be kept in S.I. units or microcuries and maintained for inspection by the appropriate Licensing Authority.

LOCATION: OZARK MED CTR. MODEL & SERIAL NO. T 780 #86

105 ALASKA AVE W. PLAINS, MO. 65775 DATE OF TEST(S): 24 MARCH 94

TESTED FOR: ^{60}Co ☑. ^{238}U ☐.

Drawer Tube in Head ☐ Collimator ☐ Source Container ☐ Other: FIRE SHIELDS

COMMENTS

Survey Meter Used: Berthold RATO/F Serial No. 574258 Calibration Date: 28 JAN 94

Berthold LB1200 Serial No N/A Calibration Date: N/A

INSTRUMENT SENSITIVITY FACTORS					
Berthold RATO/F (Window Open)			Berthold LB1200 (Window Open)		
A	B		A	B	
40 c/min	= 0.005 µCi ^{60}Co	☑	110 c/min	= 0.005 µCi ^{60}Co	☐
140 c/min	= 0.005 µCi ^{238}U	☐	1500 c/min	= 0.005 µCi ^{238}U	☐

Leak Test(s) Performed:

☐ 1. Routine wipe contamination test as detailed in the Maintenance Manual or spec. #DG 0573 as found in the Source Handler's Handbook.

(Wipe Reading 22 c/min) - (Background Reading 22 c/min) = Net Reading 0 c/min.

Contamination = Net Reading 0 c/min x $\frac{\text{(B) } 0.005 \text{ µCi}}{\text{(A) } 40 \text{ c/min}}$ = 0 µCi

NOTE: B and A are the instrument sensitivity factors listed above.

Conversion to S.I. Units
0.001 µCi = 37Bq
0.005 µCi = 185Bq

Test Evaluations:

☑ NEGATIVE Test showed less than reportable limit.

☐ POSITIVE A written contamination report will be prepared to provide initial corrective action and details.

It is hereby certified that the test(s) indicated above have been carried out by/or under the supervision of the undersigned.

D. Hoffman Jan. 25, 94 Svc. Rep.

Signed Date Title

Theratronics International Limited • 413 March Road • PO Box 13140 • Kanata Ontario K2K 2B7
(613) 591-2100 • Fax (613) 592-3816 • Telex 053-4416

RADIOTHERAPY — WIPE TEST FOR CONTAMINATION

P&S # 45956

IMPORTANT: Sources shall be tested for leakage at intervals not to exceed six months. Records of test results shall be kept in S.I. units or microcuries and maintained for inspection by the appropriate Licensing Authority.

LOCATION: OZARK MED CTR MODEL & SERIAL NO. T 780 # 86

1115 ALASKA AVE, W. PLAINS MO 65775 DATE OF TEST(S): 24 MARCH 94

TESTED FOR: ^{60}Co ☒, ^{238}U ☐.

Drawer Tube in Head ☐ Collimator ☐ Source Container ☐ Other: STRETCHER TOP ☒

COMMENTS

Survey Meter Used: Berthold RATO/F Serial No. 574258 Calibration Date: 28 JAN 94

Berthold LB1200 Serial No. N/A Calibration Date: N/A

INSTRUMENT SENSITIVITY FACTORS					
Berthold RATO/F (Window Open)			Berthold LB1200 (Window Open)		
A	B		A	B	
40 c/min	= 0.005 µCi ^{60}Co	☒	110 c/min	= 0.005 µCi ^{60}Co	☐
140 c/min	= 0.005 µCi ^{238}U	☐	1500 c/min	= 0.005 µCi ^{238}U	☐

Leak Test(s) Performed:

☒ 1. Routine wipe contamination test as detailed in the Maintenance Manual or spec. #DG 0573 as found in the Source Handler's Handbook.

(Wipe Reading 22 c/min) - (Background Reading 22 c/min) = Net Reading 0 c/min.

Contamination = Net Reading 0 c/min x $\frac{\text{(B) } 0.005 \text{ µCi}}{\text{(A) } 40 \text{ c/min}}$ = 0 µCi

NOTE: B and A are the instrument sensitivity factors listed above.

Conversion to S.I. Units
0.001 µCi = 37Bq
0.005 µCi = 185Bq

Test Evaluations:

☒ NEGATIVE Test showed less than reportable limit.

☐ POSITIVE A written contamination report will be prepared to provide initial corrective action and details.

It is hereby certified that the test(s) indicated above have been carried out by/or under the supervision of the undersigned.

D. Hoffmeyer Signed | Mar. 25, 94 Date | Svc. Rep. Title

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Form 257 Rev B

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JAN 28 '94 11:38

THERATRONICS **REPORT OF ROUTINE WIPE TEST FOR CONTAMINATION**

P & S # 45956

IMPORTANT: Sources shall be tested for leakage at intervals not to exceed six months. Records of test results shall be kept in S.I. units or microcuries and maintained for inspection by the appropriate Licensing Authority.

LOCATION: OZARK MED CTR MODEL & SERIAL NO. T 780 # 86

1115 ALASKA AVE W. PLAINS MO DATE OF TEST(S): 24 MARCH 94

TESTED FOR: ^{60}Co ☑ ^{238}U ☐ 65775

Drawer Tube in Head ☐ Collimator ☐ Source Container ☑ Other: ______ ☐

COMMENTS ______

Survey Meter Used: Berthold RATO/F Serial No. 574255 Calibration Date: 28 JAN 94

Berthold LB1200 Serial No. N/A Calibration Date: N/A

INSTRUMENT SENSITIVITY FACTORS					
Berthold RATO/F (Window Open)			Berthold LB1200 (Window Open)		
A	B		A	B	
40 c/min	= 0.005 µCi ^{60}Co	☒	110 c/min	= 0.005 µCi ^{60}Co	☐
140 c/min	= 0.005 µCi ^{238}U	☐	1500 c/min	= 0.005 µCi ^{238}U	☐

Leak Test(s) Performed:

☑ 1. Routine wipe contamination test as detailed in the Maintenance Manual or spec. #DG 0573 as found in the Source Handler's Handbook.

(Wipe Reading 22 c/min) - (Background Reading 22 c/min) = Net Reading 0 c/min.

Contamination = Net Reading 0 c/min x (B) 0.005 µCi / (A) 40 c/min = 0 µCi

NOTE: B and A are the instrument sensitivity factors listed above.

Conversion to S.I. Units
0.001 µCi = 37Bq
0.005 µCi = 185Bq

Test Evaluations:

☒ NEGATIVE Test showed less than reportable limit.

☐ POSITIVE A written contamination report will be prepared to provide initial corrective action and details.

It is hereby certified that the test(s) indicated above have been carried out by/or under the supervision of the undersigned.

D. [signature] Signed — Mar. 25, 94 Date — Svc. Rep. Title

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Form 257 Rev B

P.02

JUN 28 '94 11:38

THERATRONICS

REPORT OF ROUTINE WIPE TEST FOR CONTAMINATION

P & S # 45956

IMPORTANT: Sources shall be tested for leakage at intervals not to exceed six months. Records of test results shall be kept in S.I. units or microcuries and maintained for inspection by the appropriate Licensing Authority.

LOCATION: OZARK MED CTR MODEL & SERIAL NO. T 780 # 86

115 ALASKA AVE, W. PLAINS MO DATE OF TEST(S): 24 MARCH 94

65775

TESTED FOR: ^{60}Co ☐, ^{238}U ☑.

Drawer Tube in Head ☐ Collimator ☑ Source Container ☐ Other: _____ ☐

COMMENTS _____

Survey Meter Used: Berthold RATO/F Serial No. 574258 Calibration Date: 28 JAN 94

Berthold LB1200 Serial No. N/A Calibration Date: N/A

INSTRUMENT SENSITIVITY FACTORS					
Berthold RATO/F (Window Open)			Berthold LB1200 (Window Open)		
A	B		A	B	
40 c/min	= 0.005 µCi ^{60}Co	☐	110 c/min	= 0.005 µCi ^{60}Co	☐
140 c/min	= 0.005 µCi ^{238}U	☑	1500 c/min	= 0.005 µCi ^{238}U	☐

Leak Test(s) Performed:

☐ 1. Routine wipe contamination test as detailed in the Maintenance Manual or spec. #DG 0573 as found in the Source Handler's Handbook.

(Wipe Reading 22 c/min) - (Background Reading 22 c/min) = Net Reading 0 c/min.

Contamination = Net Reading 0 c/min x $\frac{\text{(B) } 0.005 \text{ µCi}}{\text{(A) } 140 \text{ c/min}}$ = 0 µCi

NOTE: B and A are the instrument sensitivity factors listed above.

Conversion to S.I. Units
0.001 µCi = 37Bq
0.005 µCi = 185Bq

Test Evaluations:

☒ NEGATIVE Test showed less than reportable limit.

☐ POSITIVE A written contamination report will be prepared to provide initial corrective action and details.

It is hereby certified that the test(s) indicated above have been carried out by/or under the supervision of the undersigned.

R. Verhaeghen Mar. 25, 94 Svc. Rep.

Signed Date Title

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(613) 591-2100 • Fax (613) 592-3816 • Telex 053-4416

THERATRONICS **REPORT OF ROUTINE WIPE TEST FOR CONTAMINATION**

P&S # 45956

IMPORTANT: Sources shall be tested for leakage at intervals not to exceed six months. Records of test results shall be kept in S.I. units or microcuries and maintained for inspection by the appropriate Licensing Authority.

LOCATION: OZARK MED CTR MODEL & SERIAL NO. I780 #86

415 ALASKA AVE W. PLAINS MO. 65775 DATE OF TEST(S): 24 MARCH 94

TESTED FOR: ^{60}Co ☒ ^{235}U ☐

Drawer Tube in Head ☐ Collimator ☐ Source Container ☒ Other: _____ ☐

COMMENTS _____

Survey Meter Used: Berthold RATO/F Serial No. 574258 Calibration Date: 28 JAN 94

Berthold LB1200 Serial No. N/A Calibration Date: N/A

INSTRUMENT SENSITIVITY FACTORS					
Berthold RATO/F (Window Open)			Berthold LB1200 (Window Open)		
A	B		A	B	
40 c/min	= 0.005 µCi ^{60}Co	☒	110 c/min	= 0.005 µCi ^{60}Co	☐
140 c/min	= 0.005 µCi ^{235}U	☐	1500 c/min	= 0.005 µCi ^{235}U	☐

Leak Test(s) Performed:

☒ 1. Routine wipe contamination test as detailed in the Maintenance Manual or spec. #DG 0573 as found in the Source Handler's Handbook.

(Wipe Reading 22 c/min) - (Background Reading 22 c/min) = Net Reading 0 c/min.

Contamination = Net Reading 0 c/min x $\frac{\text{(B) } 0.005 \text{ µCi}}{\text{(A) } 40 \text{ c/min}}$ = 0 µCi

NOTE: B and A are the instrument sensitivity factors listed above.

Conversion to S.I. Units
0.001 µCi = 37Bq
0.005 µCi = 185Bq

Test Evaluations:

☒ NEGATIVE Test showed less than reportable limit.

☐ POSITIVE A written contamination report will be prepared to provide initial corrective action and details.

It is hereby certified that the test(s) indicated above have been carried out by/or under the supervision of the undersigned.

D. Ingberger Mar. 25, 94 Ser. Rep.

Signed Date Title

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(613) 591-2100 • Fax (613) 592-3616 • Telex 053-4416

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